MOGENS JENSEN

Beekeeping with Apis cerana indica

SOME IMPORTANT ASPECTS OF COLONY MANAGEMENT

Beekeeping with Apis cerana indica
-Some important aspects of colony management

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Lay out: Mogens Jensen

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Introduction

This book is primarily intended for extension workers and beekeepers, but should also be useful as background information to project planners and administrators in the development sector.

The focus of the book is the equipment and management methods suitable for small scale beekeepers in rural areas.

The book does not attempt to deal with all aspects of beekeeping with *Apis cerana indica*. Rather it deals with some of the common problems in practical beekeeping I have seen beekeepers encounter during nearly 20 years work as advisor to Asian beekeeping projects. Some of the solutions suggested here may be considered controversial when compared to conventional management practice for *Apis cerana indica*, but the main focus has been to devise simple equipment and management methods beekeepers can use to improve the income from their beekeeping.

The equipment and methods suggested in the book are mainly developed and tested in India, Vietnam and Bangladesh. A transfer to other areas of Asia will require adjustments to the actual ecological, social and cultural context. It is also important to make the adjustments of measurements of equipment required by the different subspecies of *Apis cerana*.

The process of adapting to the whole actual context for rural beekeeping is crucial for success. Unfortunately there is a tendency to focus on either the socio-cultural context without considering the technical knowledge needed, or, to get lost in the technical intricacies without considering the importance of the socio-cultural setting. Both groups usually fail to achieve sustainable success in beekeeping projects. The simple fact is that the long-term incentive for a rural beekeeper to keep bees - is to earn money. And earn it in a way where the input of time and investments produce a worthwhile profit.

For any socio-cultural setting the profit perspective requires a design of equipment and management methods simple and easy to use. It should preferably be equipment which can be produced in the village from locally available materials and thereby adapts to the local investment capacity and limit dependence on input from outside. The crucial matter is: At the same time the equipment has to be simple and easy to use and also have a tested, high level of productivity and adaptation to the local bees is very important to maximise profit.

It is my hope the book will help to benefit rural beekeepers in their efforts to improve the profit of their beekeeping.

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I also feel indebted to a large number of beekeepers from India, Pakistan, Nepal, Bangladesh, Myanmar and Vietnam for their interest, cooperation, ideas and willingness to tell me about beekeeping in their areas and for giving me the opportunity to work with their hives. Without their help this book would not have been written.

Nykøbing Mors, Denmark. January 2007

Mogens Jensen

Chapter 1: Hives

From honey hunting to beekeeping

For thousands of years honey has been highly valued by man, not only as a food but also for the widespread use in traditional medicine and religious rites. The collection of honey were important events in the life of ancient people, and has been shown in rock paintings from India, Europe, Africa and Australia; all depicting hunters collecting honey from nests of wild bees. – Honey hunting is still today the source of a substantial part of the honey and bees wax used in Southeast Asia. In rural beekeeping projects the knowledge of honey hunters can be a valuable resource for information on flora, density of all three indigenous honeybee species nesting sites and preferences as well as patterns of seasonal migration of bees.

Toda forest beekeeping

Fig. 1.1 A Toda beekeeper inspecting a cavity

Fig. 1.2 Stones are used to reduce the size of entrance and protect the bees

An intermediate stage between honey hunting and beekeeping is found among several of the indigenous people living in the hilly areas of Western Tamil Nadu in India. In the upper areas of the Nilgiris there is a small tribal population of Todas.

The Toda way of beekeeping represents the intermediate stage very well. When a new tree- or rock cavity with bees is found during the honey season the entrance is enlarged sufficiently to put a hand inside the cavity for harvesting any surplus honey. By fixing stones the area of the entrance is reduced, only a small entrance is left for the bees. No further management is done and the bees are left to migrate during the summer.

Before the bees return at the end of the year a Toda forest beekeeper will clean the cavities and ensure the stones are in place. Only what the Todas consider surplus honey is harvested. A Toda forest beekeeper

can maintain several hundred cavities, but bees will not settle in all cavities every year.

Traditionally there was ownership to the cavities, which also could be inherited from one generation to another.

Transportable beehives

Fig. 1.3 Log hive from Vietnam

The first transportable beehives could have been logs – with bees – cut from trees, and shifted to a more convenient place. Keeping the bees close a house, made safeguarding and caring for the bees easier. Hives made from straw, bark, clay, and wood, woven baskets and - later – pottery might also have been used. In Egypt there is a tradition – since 3500 years – to keep bees in long cylindrical hives made of mud or clay. In Europe, straw skeps were used for keeping bees for centuries, or perhaps millenniums.

Through the span of time, some beekeepers have probably been grappling with the basic problems in hive design:

How to protect the bees against harsh climatic conditions and predators?

How to harvest a maximum of honey and wax without destroying the colony?

For thousands of years solutions to problems in hive making had to be found in local skills and locally available materials. Intuitive understanding of technical problems has provoked inventions suited to solve the problems in a local context. Little is known, and only little remains to show how methods of *Apis cerana* beekeeping developed throughout Asia.

Fixed comb and moveable comb hives.

There are two basic concepts of beehives:

The fixed comb hive where the beekeeper provides a hive with a cavity for the bees to build their combs fixed to the inner surface of the hive. Log hives and wall hives are usually fixed comb hives, where the beekeeper cannot take out combs for inspection and replace them again. Honey is harvested by cutting single combs.

Some fixed comb hives - like log hives - can be turned into moveable comb hives and be improved considerably by providing top bars for the bees to build combs on.

Moveable comb hives are fitted with top bars or frames for comb building. The use of top bars or frames became possible after discovering the concept of “bee space”: The fact that bees – according to their body size – when building combs will try to keep a certain distance from one midrib of a comb to the next combs midrib. This is called the centre to centre (c-c) distance. There is a correlation between body size of bees and the c-c distance used. Provided the c-c-distance is suitable for the bees only one comb will be built on each top bar or frame. This allows the beekeeper to take out individual combs and gives far better options for management of the bees. Moveable comb hives for *Apis cerana* was introduced in India during colonial times.

Examples of multi-storey box hives

Fig. 1.4 There is not much difference in these box hives from Bangladesh, Nepal and India

Fig. 1.5 All the parts needed for a box hive make it less suitable for beekeepers that want to make their own equipment

Top bar hives and fixed comb hives

Fig. 1.6 A Mulderry hive

Fig. 1.7 A swarm being settled in a hive made from fired clay

Fig. 1.8 In a hot and dry climate colonies thrive well in pottery hives

Fig. 1.9 A well-shaded hive made from an old packing case

Fig. 1.10 A short and wide top bar hive made from wood

Fig. 1.11 A log hive made from a coconut trunk

Fig. 1.12 Mulderry hive on a very stable hive stand made from steel rods

Fig. 1.13 A long and narrow top bar hive is not as suitable as a short and wide

Fig. 1.14 Log hive with top bars

Fig. 1.15 A combination of wired frames and honey storage in burr-comb

Fig. 1.16 Fixed comb hive made from an old packing case

Fig. 1.17 Pottery hive. In concept close to the top bar hive from Greece as described by Wheler in 1682

Fig. 1.18 Fixed comb hive made from a water jar

Fig. 1.19 A sturdy top bar hive made from fired clay

Fig. 1.20 Space is utilized very well in top bar hives

Chapter 2: Designing a beehive

Throughout the distribution area of *Apis cerana indica* few efforts have been made to determine the basic factors in designing hives, as well as management methods, appropriate to the local bees and conditions. The diversity found in different ecotypes of Apis cerana indica makes it impossible to design one standard hive covering all variations needed.

The correlation between hive design and the management needed for a particular design should also be considered. A professional beekeeper with hundreds of hives may do well with a multi storey box hive design requiring a high level of management. Small-scale beekeeping with a few hives and ability as well as time only for a low level of management will require a very different hive design to do profitable beekeeping.

Designing hives for a specific purpose is also a partly unexplored field. Maximum honey production may be expected to be main goal of beekeeping, but there are other needs to satisfy: Comparison tests between Newton and Mulderry hives shows the Mulderry hive to be superior in production of brood and bees. This specific property is useful to produce:

- Brood combs and bees to form new colonies and supporting weak colonies.
- Strong colonies for queen rearing
- Strong colonies for pollination of crops. The value of pollination far exceeds the value of honey production.
- Bee brood for eating. A delicacy and a highly valued product among many ethnic minorities in Asia.

The end-user context influences hive design. When I use the Mulderry hive as an example of the design process it is essential to remember the context for which it was designed; a development project aimed at income generation for people with very limited resources for investments in equipment, management and time used for beekeeping.

The aim was therefore to design a beehive that could:

Be made from cheap, easy accessible and durable materials.

Be made, using only the skills of local people.

Give the beekeeper easy access to maintenance, harvest of honey and wax.

Require a low level of management.

Be appropriate to colony size and behaviour of the local bees.

Allow the bees to keep a stable microclimate in the hive.

Protect the colony against the different climatic conditions in the area.

To some extent protect the bees against pests and predators.

The final design proved to be suitable for the context. In other countries where the design is being used it has to be modified to be appropriate to the local situation.

If the task had been to design a hive suitable for a large-scale professional beekeeping operation the hive design would probably have been very different.

Appropriate to bees

Fig. 2.1 Measuring temperature and humidity is a way of comparing hive designs

In designing a new beehive there are several technical factors of crucial importance: the volume, the possible comb area, the distance between the combs, the micro climate in the hive, the bees possibility to defend themselves against intruding predators and the sort of materials used for the hive.

It is important to realize, that not one factor, but the interaction between all the factors is decisive for the suitability and productivity of a hive.

Whether a beehive is appropriate to local bees can be decided mostly by measuring quantity, i.e. size of colonies, absconding rate or honey production.

Appropriate to people.

Fig. 2.2 Beekeeping based on traditional skills and available materials make the beekeepers independent

Apart from being appropriate to bees, it is obvious that a new beehive should be appropriate to its future users: the beekeepers. Adaptation to local skills tools and materials are also essential.

A process of defining „appropriate“ with the beekeepers must be given first priority. - But, it is important to realize that if other groups of people are involved in the project at other levels; their concept of „appropriate“ (to their situation) can be different. The staff in a project might regard the use of simple, easily

understandable, low cost technology based on local resources as a threat to their status and jobs. Acceptance of the goal of a project from all involved is a precondition for success.

What is C- C distance?

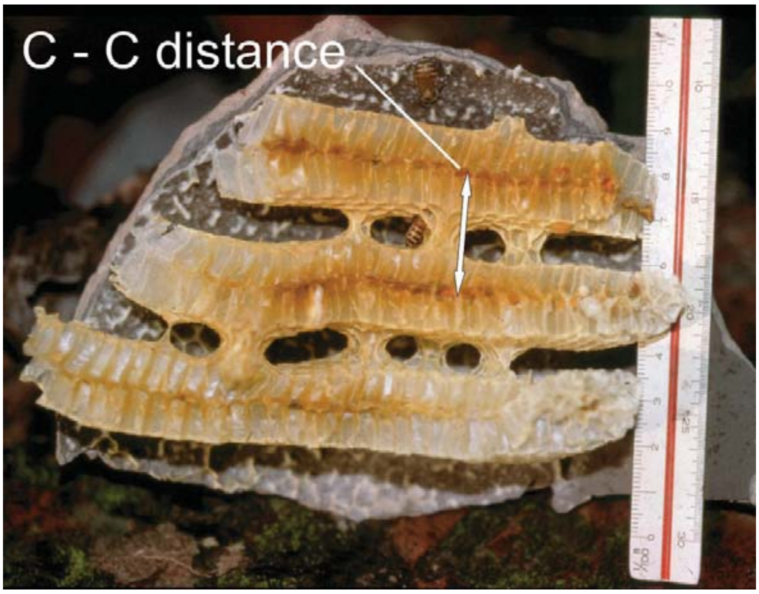


Fig. 2.3 Measuring the c-c distance to adapt to the local bees

Wherever wild bees build their nest, they will always keep a fixed distance - depending on their body size - between their combs. It is called the c-c distance, and is measured from the midrib of one comb to the midrib of the next comb.

In a beehive we are providing the bees with frames or top bars, on which they build their combs. It is to make it possible to remove combs from the hive for inspection or harvest of honey without destroying the whole nest. To make sure the bees only build one comb on each frame or top bar, the spacing of frames or top bars must be in accordance with the c-c distance used by the local bees.

How to find the c-c distance:

Fig. 2.4 A colony left tobuild combs on the top board for measuring c-c distance

In Mulderry we used a number of ways to find the correct c-c distance:

Bees were kept in hives without frames or top bars. The bees build their combs on a plain piece of wood, a top board. After transferring the colony to another hive the c-c distance could easily be measured on the top board.

Bees kept in clay pots (water jars) were transferred to other hives and the comb pattern measured on the sides of the broken jars.

When capturing feral bee colonies to be used in the apiary the c-c distance was measured in the nests.

Results:

Regarding point A, B and C the mean c-c distance was found to be 26,1 mm with a variation between colonies up to 0,9 mm.

Testing results

Tests were made in hives fitted with top bars respectively 21 mm, 25,4 mm and 31 mm wide. The 25,4 mm was chosen because it equal to one inch. Carpenters in Bangladesh prefer to use inches instead of metric units.

The total numbers of combs build, and the number of combs fixed on more than one top bar were counted for each size of top bars. Combs fixed to more than one top bar were considered as failures.

Fig. 2.5 Two combs built on 3 top bars was common with a 21 mm c-c distance

Table 1
Failure in % combs with different widths of top bars

With of Top bar	21 mm	25,4 mm	31 mm
% Failures	78 %	8 %	19 %

A conclusion - and its adaptation to practical use.

Calculating the percentage of failures for each size of top bars, there was no doubt that the bees in Mulderry preferred top bars with a width of 25,4 mm (one inch). Even though the correct distance regarding point A, B and C was found to be 26,1 mm, in practical use one inch (25,4 mm) was easier to remember; a carpenter could underst-and it, and it was a significant improvement compared to the c-c di-stance (33 mm) in Newton hives.

Fig. 2.6 Colonies kept inside houses developed fast and formed large colonies

The volume of the hive – a key to larger colonies?

The volume of a hive affects the bees' behaviour. A small volume will soon be filled with combs, crowded with bees and swarming induced. If a beekeepers purpose of keeping bees is

production of honey swarming is undesirable, because half of the bees will leave the hive with each swarm and few bees be left to produce honey.

Providing excess hive space can be a way to reduce swarming and shunt resources into brood and honey production.

The Newton hive used in Bangladesh had a volume of approximately 10,2 litres and is too small to utilize the potentials for profitable beekeeping with *Apis cerana indica.*

The Mulderry hive has a volume of 16,5 litre when used for Apis cerana indica. For Apis cerana cerana a volume of 30 – 35 litre is more appropriate.

Sloping walls in the hive

Fig. 2.7 Apis cerana indica will seldom fasten the combs to the walls of the hive

It is a general assumption, that bees kept in top bar hives are less likely to fix their combs to the sides of the hive when the sides are sloping a little out from the bottom. For Apis mellifera top bar hives it is a necessity, for *Apis cerana indica* is an advantage, but not a must. In the final version of the Mulderry hive the sides are sloping, but a number of Newton hives fitted with top bars instead of frames have been used in experiments without problems.

How to get more comb area in the same volume?

Fig. 2.8 Apis cerana indica combs are rarely built to fill all the space in the frame

Efficient use of the volume in a hive - and the materials used for the hive - can help the bees to concentrate fewer resources on keeping a stable microclimate in the hive.

When frames are used for *Apis cerana indica,* the combs are rarely built to fill all the space in the frame. This and the space occupied by the wood used for the frame as well as the space between the frame and the wall of the hive represent a lost opportunity for comb building. The use of top bars eliminates this problem.

Newton hives:

Measuring the mean comb area in Newton hives (frames), it was found to be 260 cm² (one side). With seven frames (c-c distance 33mm) in the hive the total comb area is 3640 cm². The volume of a Newton hive is 10,2 litres.

The comb area per litre is 357 cm²

Fig. 2.9 A Newton hive

Mulderry hives:

In Mulderry hives (top bars) the mean comb area is 315 cm² (one side). With 18 top bars (c-c distance 25,4mm) in the hive the total comb area is 11340 cm². The volume of the Mulderry hive is 16,5 litre.

The comb area per litre is 687cm²

Fig. 2.10 A Mulderry hive

The comb area per litre volume of hive seems to be an unnoticed but important factor in hive design.

This example shows us how we by changing two factors; the c-c distance from 34 mm to 25,4 mm and giving the bees the possibility to utilize the space in the hive better by using top bars in stead of frames, have achieved nearly the double comb area in the same volume.

Table 2 Specifications of Mulderry hives and Newton hives

Specifications	MULDERRY HIVE	NEWTON HIVE
Volume	16,5 litre	10,2 litre
Possible number of combs	18 on top bars	7 in frames
Possible comb area both sides included	11.340 cm²	3.640 cm²
C - C distance	25,4 mm (one inch)	33 mm
Comb area per litre	687 cm²	357 cm²
Materials	Cane/bamboo	Wood

Comparing colony development

To compare colony development in Mulderry hives versus Newton hives, 20 colonies – with an average of 3 brood combs - were hived; 10 in Mulderry hives and 10 in Newton hives. Each group was split in 2 groups of 5 hives. 5 Mulderry hives and 5 Newton hives were left to feed on natural nectar- and pollen sources in the apiary. The remaining 10 hives were feed with inverted sugar syrup made from 2 kilos of sugar boiled with 1 litre of water and 4 ml of lactic acid (Mulderry syrup)

Fig. 2.11 Measuring comb areas with a grid

By using a grid colony development was measured in each of the 20 hives, as cm² of brood area and cm² of total comb area.

The experiment was stopped when colonies in Newton hives fed the inverted sugar had built the maximum possible comb area and started swarming.

After the experiment ended colony development in Mulderry hives were followed. Of the 10 colonies 2 were lost in a storm, the remaining 8 colonies developed to an average total comb area of 9340 cm² without swarming or absconding.

Table 3
Comparison of colony development between Mulderry and Newton hives.

Type of hive:	Non - fed colonies	Colonies fed with Mulderry syrup
Mulderry hives: Mean brood area per colony /cm²	2.220 cm²	4.188 cm²
Newton hives: Mean brood area per colony /cm²	1.014 cm²	2.555 cm²
Mulderry hives: Total comb area per colony /cm²	5.050 cm²	6.733 cm²
Newton hives: Total comb area per colony /cm²	2.795 cm²	3.566 cm²

A significant difference in colony development was found between Mulderry and Newton hives in all groups. Non-fed colonies in Mulderry hives developed to twice the size of non-fed colonies in Newton hives within the same period of time.

Another significant difference of the mean brood area and the total comb area was found between non-fed colonies and colonies fed with Mulderry Syrup:

- 64 % more brood (and bees) were found in Mulderry hives fed with Mulderry Syrup than in Newton hives.
- In Newton hives fed Mulderry Syrup the mean brood area increased 150 %.
- The total comb area in colonies fed Mulderry Syrup is approximately 100 % larger in Mulderry hives than in Newton hives.

A new innovation for Top bar hives.

Interviews showed that 25 % of the beekeepers had been exposed to vandalism or theft from their hives. To combat the problem it was tested if hives could be hung indoors in houses at level with the eaves.

Locating beehives in houses provoked a new innovation. To suit needs for easy inspection the base part was made with hinges so it could be opened. This gave two advantages; inspection could be done from below more quickly and without removing the combs and disturbing the bees. It also made it easier to remove wax-debris from the bottom board. This was a hygienic advantage because many pests develop in the wax-debris.

Fig. 2.12 Inspecting the colony from below. The small pot is for feeding the colony

Size of the entrance.

Fig. 2.13 The entrance of the hive should not exceed a height of 6 mm to prevent wasps to attacking the colony

Selecting materials for the hive

The material to be used had to fulfil a number of requirements:

Protect the colony against harsh climatic conditions.

Allow the bees to keep a stable microclimate in the hive.

Protect the bees against predators.

Be cheap, easy accessible, durable and lightweight.

Preferably materials, which the local people had skills in using.

Below some of the characteristics of the new hive are described. It exemplifies how the local skills and knowledge together with modern scientific methods can be meshed to produce the desired results.

Traditional techniques used in basketwork, boat and house building as well as making fishing net have proved usable for improving the experimental hives.

Bamboo and cane – available in the local area.

Fig. 2.14 Smoking hives to protect against the bamboo borer

The Mulderry hive is a rectangular basket made from bamboo and cane (*Calamus spp.*). The use of bamboo and cane has a long tradition in Bangladesh. In a warm and humid climate these materials are better suited than wood for many purposes. In hives made from wood, condensing water is often observed to spoil the microclimate. Cane and bamboo are cheap, available in local areas, and there are widespread traditional skills for working with these materials.

Wood from teak (*Tectonic grandis*), Jackfruit (*Artocarpus integrifolia*) and Mango (*Magnifera indica*) have been used for making hives, but wood is more expensive and requires more tools and other skills than the use of cane and bamboo.

The bamboo borer can be a problem when using bamboo. Smoking the bamboo using dry bamboo leaves make the material partly resistant to insect attacks. Keeping the bamboo in water for 20 days will have the same effect.

Coating - for fishing nets and beehives.

Fig. 2.15 Crushing Gab fruit with a rice husker

An outside coating was needed to protect the hive against the monsoon rain and to prevent ants and wax moths (*Galleria mellonella*) as well as other predators to enter the hive. A female beekeeper suggested using a technique for coating fishing net. When tested it had the needed quality. This „Mulderry“ mixture is made from unripe fruits of Gab (*Diospyros peregrina*), which have been crushed in a rice husker and then soaked in water for half an hour. The liquid is mixed with rice husks and used for coating the outer side of the hive. Left in the sun for one day it dries up and form a waterproof and durable coating. Other coatings like cow dung and clay have been tested but are not suitable.

Fig. 2.16 A thin layer of coating is sufficient

Clay coating - cheap, available and very useful.

Coating the inner side of the hive was necessary to seal cracks and smoothen the surface for hygienic reasons. A coating made from clay mixed with water proved to be a choice serving several purposes. It prevented wax moths from reproducing in cracks. Measurements on fluctuation of the internal humidity and temperature showed that a clay coating made it easier for the bees to keep a more stable microclimate in the hive. The clay coating function as a buffer to stabilize temperature and humidity. This could be a part of the explanation why there is a lower frequency of absconding with clay coating.

Different places – other materials

When using the Mulderry hive in other places it has been necessary to adapt to materials and techniques these areas. Here are some examples from Palni Hills in India.

Fig. 2.17 Testing different materials for coating

Fig. 2.18 No fine grey clay was available in Palni Hills. Soil from termite mounds was pounded, sieved and used for inside coating


Fig. 2.19


Fig. 2.20

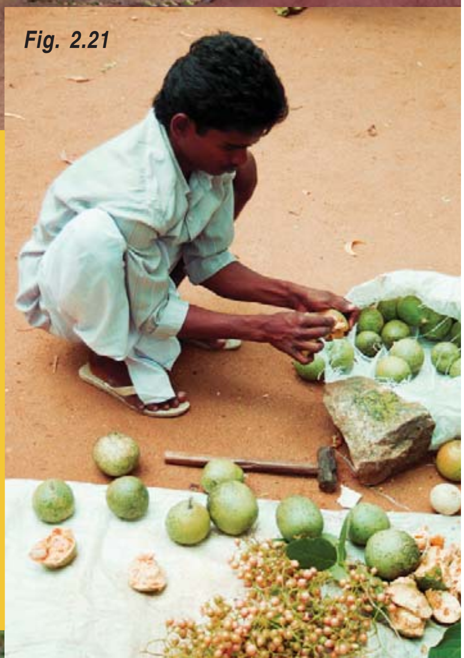


Fig. 2.21

None of the materials used in Bangladesh were available in Palni Hills. Even the bamboo was a different variety. New suitable materials had to be found and tested.

For the framework of the hive bamboos two bamboos were tried Bambusa arundinacea and Dendrocalamus strictus (Fig.2.19 + Fig. 2.23). The later proved to be the most economical.

A creeper Combretum ovalifolium (Fig. 2.20) was tried for the weaving but a bamboo Ochlandra travancosica proved more suitable.

For the outer coating „Wood Apple“ Aegle marmelos (Fig. 2.21 and „Trumpet flower“ Pedalyum nurex (Fig. 2.22) was tested. Finally dried, pounded leaves of Albizzia amara mixed with rice husk and water was suggested and found to be a better choice.


Fig. 2.22


Fig. 2.23

Coating a hive with a mixture of dried, pounded leaves of Albizzia amara mixed with rice husk

Finding new ways of making a hive

The importance of temperature and humidity

During the work with the Mulderry hive in Bangladesh there proved to be a strong correlation between a stable microclimate in the hive and how fast and to what size colonies developed.

Bees spend energy to maintain a stable and optimum microclimate in the hive. To keep temperature down water will have to be fetched, distributed in the hive and evaporated. Also fanning will have to be done. Increasing the internal temperature requires a higher level of metabolism. Both situations require resources, meaning nectar and pollen to be collected.

In hives that facilitate the bees for maintaining a stable optimum temperature and humidity in the hive despite fluctuations in the surrounding environment less resources will be used. Efficient use of the volume in a hive - and the materials used for the hive - can help the bees to concentrate fewer resources on keeping a stable microclimate. With less resources spent on keeping an optimum microclimate it seems the saved resources are shunted into more brood rearing, resulting in larger and more productive colonies.

Fig. 2.24 Measuring internal and external temperature and humidity

Temperature and humidity are the two basic parameters to be measured for getting information on the microclimate in the hive. Both internal and external humidity and temperature should be measured in the hives to be compared. In the graph below is shown results for only one hive and in- and external temperature as an example of what the bees have to cope with.

The thumb rule is simple when comparing different types of hives – provided the circumstances are equal: The hive with the most stable microclimate will provide the bees with the best opportunities to develop large and productive colonies fast.

Fig. 2.25 A data logger with a storage capacity of 2048 samples of temperature and humidity has been designed. Further information from Palni Hills Conservation Council Post box 34 Kodaikanal 624 101 Tamil Nadu India

Table 4 Fluctuations in temperature KDM 2

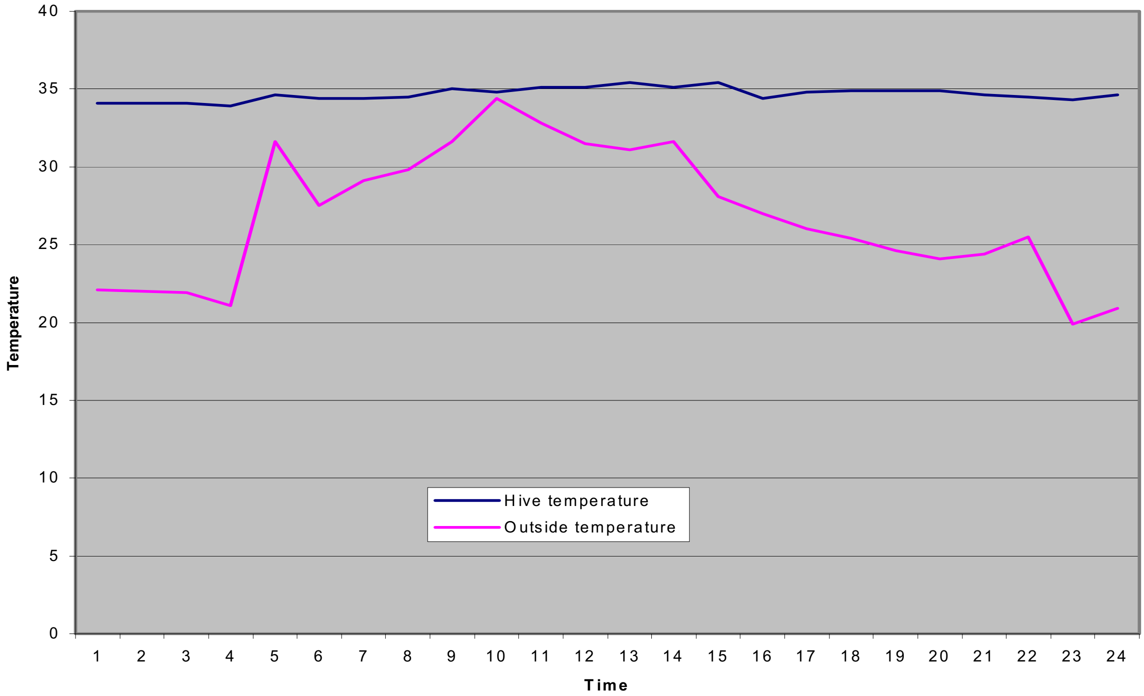


Table 5 Fluctuations in temperature and humidity

PLACE: XXX DATE: 04.03.2001 HIVE TYPE AND NO: KDM2 SIGN:

Time	Hive Temperature	Outside Temperature	Outside Humidity	Hive Humidity	Activities of bees: Incoming bees Collect Pollen	Nectar & Water	Fanning	Outgoing
07:30	33,9	21,1	80%					
08:30	34,6	31,6	78%					
09:30	34,4	27,5	72%		33	8	0	45
10:30	34,4	29,1	63%		53	52	0	39
11:30	34,5	29,8	55%		22	23	0	13
12:30	35,0	31,6	44%		33	42	0	18
13:31	34,8	34,4	46%		19	32	0	1
14:30	35,1	32,8	36%		6	27	0	12
15:30	35,1	31,5	40%		6	7	0	2
16:30	35,4	31,1	40%		11	151	0	84
17:30	35,1	31,6	42%		18	15	0	1
18:30	35,4	28,1	52%		4	11	0	3
19:30	34,4	27,0	53%					
20:30	34,8	26,0	55%					
21:30	34,9	25,4	57%					
22:30	34,9	24,6	61%					
23:30	34,9	24,1	62%					
24:30	34,6	24,4	65%					
01:30	34,5	25,5	68%					
06:30	34,3	19,9	100%					
07:30	34,6	20,9	88%		32	41	0	-

The feral nest

Studying the natural nests of A. cerana can give some valuable information for appropriate hive design. It is important to analyse to which extent the actual environment of the particular area affects findings.

Fig. 2.26 A natural cavity with a colony

Fig. 2.27 Collecting information on feral colonies

The ideal area for a study would be a virgin forest without trace of human intervention. Nesting sites; cavities in the ground or old trees would be abundant, giving the bees a choice of the best possible place for a nest. Diversity of floral sources and density of bee colonies would be to the limit of the areas carrying capacity. Only the weather of changing seasons, predators, diseases and migration patterns of the bees would influence the number and size of bee colonies. Over millions of years of evolution bees adapted to ecosystems where there were no human interference.

Reality – today - is different. Human intervention has – in many places – irreversibly changed the environment. Studying bees in man made environments - t. ex areas under agriculture or commercial forestry – tells us about the bee's ability to adapt to limitations of new environments. But such a study does not tell how bees would behave under more favourable conditions.

Data collected from feral nests is a reasonable entry point for designing beehives, but should definitely be follow by extensive trials to test if hives are appropriate to utilize A. cerana indicas potential to develop into large and productive colonies.

Let me illustrate differences between feral colonies and colonies kept in hives with data from 53 feral colonies and 47 colonies kept and managed in Mulderry hives. All data were collected in Mulderry apiary; Bangladesh from 1989 to 1994.

Volume of cavity: In feral nests the mean volume was found to be 23,4 litre. In hives, the best results were achieved with a volume of 16 to 20 litres.

Number of combs: *A. cerana indica* is generally believed to build seven combs in its nest. In feral nests the mean was found to

be 6,7 combs per colony. Kept and managed in Mulderry hives - 6 months after hiving - the mean was found to be 15,7 combs per colony.

Fig. 2.28 Combs build with out frames or guides

In Palni Hills, Tamil Nadu, India it was found possible to "harvest" 20 to 22 brood combs per year – for production of new colonies - from colonies kept in a slightly modified version of the Mulderry hive.

Total comb area: In feral nests the mean total comb area was 2419 cm2 while in Mulderry hives (6 months after hiving) the mean was found to be 9491 cm2 comb area per colony. (Both sides of combs included)

Cell dimensions: In feral nests as well as in hives the mean cell size for worker cells was 4,25 mm. (Measured over 10 cells and - of course - on combs build without comb foundations.)

Centre to centre distance of combs: In feral nests the mean c-c distance was found to be 26,1 mm with a variation between colonies up to 0,9 mm. In hives for top bars 25,4 mm (one inch) wide was chosen. Including unavoidable wax residues, dirt and warping of wood this will give an actual c-c distance close to 26 mm. for top bars.

Chapter 3: How to make a Mulderry hive

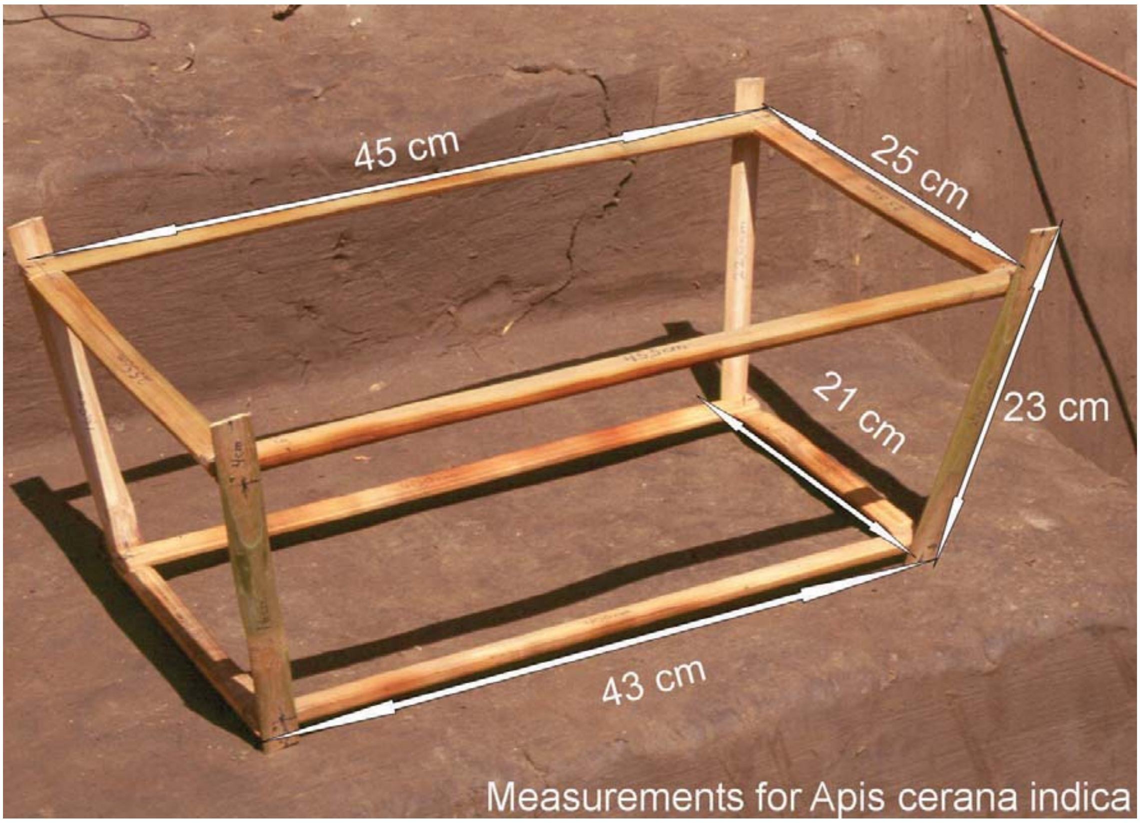


Fig. 3.1 Measurements for making a Mulderry hive for Apis cerana indica

To make a Mulderry hive you will need the following materials:

Bamboo:

For the inner frames: 6 pieces 2 centimetres wide, 0,8 centimetre thick and 42,2 centimetre long.

For the walls:65 pieces 1 centimetre wide 0,2 - 0,3 thick and 23 centimetres long.

For reinforcing the upper edge: 4 pieces 1,5 centimetre wide, 0,2 - 0,3 centimetre thick and 45 centimetre long. 4 pieces 1,5 centimetre wide, 0,2 - 0,3 centimetre thick and 25 centimetres long.

For the base part::

10 pieces 1 centimetre wide, 0,2 - 0,3 centimetre thick and 43 centimetre long.

4 pieces 1,5 centimetre wide, 0,3 centimetre thick and 42 centimetre long.

6 pieces 1,5 centimetre wide, 0,2 - 0,3 centimetre thick and 21 centimetre long.

Split cane: Approximately 60 metres of it with a diameter of 0,6 centimetre across.

Small nails. Some glue. Clay. Water. 10 unripe fruits of *Diospyros peregrina*. (A type mangosreen.) or dried, pounded leaves of Albizzia amara for coating. Some medium fine rice husk.

Fig. 3.2 Splitting bamboo

Wood for top bars:

18 pieces of wood, 2,54 centimetre (one inch) wide, 0,8 centimetre thick and 24,5 centimetre long.

18 pieces of wood. Triangular 1 centimetre x 1 centimetre x 1 centimetre. 20 centimetre long.

Rubber band (Old rubber tubes from a car): 5 pieces 2,5 centimetre wide, 10 centimetre long.

Tin sheet for top cover: 1 pieces 56 centimetre long and 38 centimetre wide.

White paint.

Tools needed:

Plane, saw, hammer, dao (A large curved knife to cut the split cane.)

Smoking the bamboo.

To prevent insects from damaging the hive, it is necessary to first smoke the bamboo. Use an old clay pot without bottom. Fill it with dry bamboo leaves. Light the fire from the bottom.

When the bamboo is cut in pieces, ready for use, smoke it carefully to prevent insects from destroying your new hive. Instead of smoking the bamboo the hive can be smoked when completed.

Another way to control insects is to keep the bamboo under water for 20 days, before use.

Fig. 3.3 Smoking bamboo

How to start.

Fig. 3.4 The frame made from bamboo

Start making the bottom frame. Cut 2 pieces of bamboo 2 centimetres wide, 0,8 centimetres thick and 42 centimetres long and 2 pieces 2 centimetres wide, 0.8 centimetres thick and 21 centimetres long.

Carve and nail the frame as shown in the photo.

For the top frame use 2 pieces 2 cms wide, 0,8 thick and 45 cms long and 2 pieces 2 centimetres wide 0,8 centimetres thick and 25 centimetres long. Carve and nail the frame.

Next step.

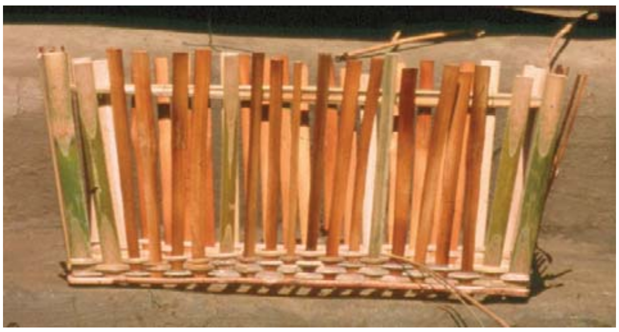


Fig. 3.5 The weaving has just begun

Now you will need the 65 pieces of bamboo 1 centimetre wide, 0,2 - 0,3 centimetres thick and 23 centimetres long.

Use a piece of split cane to fasten the sticks provisionally to the bottom frame.

Place 22 pieces on each long side of the frame, and 10 on each end.

Place the top frame 16 centimetres over the bottom frame. Start weaving with the split cane along the bottom frame.

When you have filled the space between the bottom frame and the top frame with split cane weaving, secure the weaving with a piece of thick split cane nailed along the top frame.

Nail a similar piece along the bottom frame.

Fig. 3.6 Notice the piece of cane supporting the weaving at the base

Fig. 3.7 Still a bit rickety

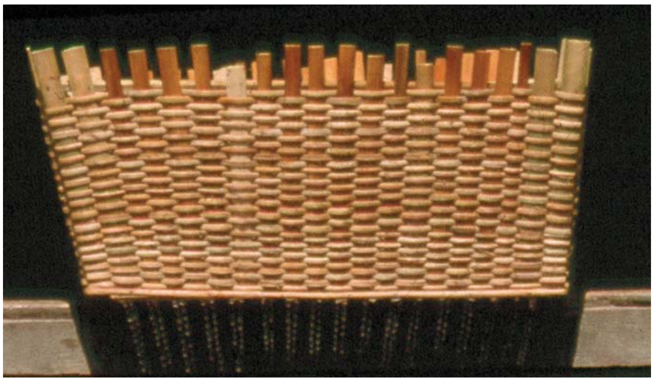


Fig. 3.8 Tight weaving improve stability

Fig. 3.9 Making the corners neat is important to keep the shape

Reinforcing the upper edge

Fig. 3.10 A

Fig. 3.10 B

Cut the vertical bamboo sticks 1,5 centimetres above the top frame. Place a piece of bamboo 1,5 centimetres wide, 0,2 centimetres thick on each side of the vertical sticks, cover the bamboo with split cane and secure it with thin split cane transversely to the edge.

Fig. 3.10 C

Fig. 3.10 A + B + C
Details of reinforcing the upper edge

How to make the base part

Make a frame. Use 2 pieces of bamboo 1.5 centimetres wide, 0.3 centimetres thick and 42 centimetres long. 4 pieces 1.5 centimetre wide and 0.2 centimetre thick and 21 centimetres long.

Fig. 3.11 Details on the base part

Place 10 pieces of bamboo 1 centimetre wide and 0,2 centimetres thick and 43 centimetres long on the frame.

Fasten the sticks in one end and cover all space in between with split cane weaving.

A hinged base part - for easy cleaning and inspection.

Fig. 3.12 Making the hinged base part

Fasten the base part to the upper part by using 3 bands of rubber 2.5 centimetres wide and 10 centimetres long. Place them under the cane band on the upper part and nail them.

On the opposite side place 2 rubber bands, each 8 centimetres from the centre of the hive, 2.5 centimetres wide and 10 centimetres long. Nail them under the bamboo frame on the base part.

Place a piece of bamboo 18 centimetres long, 4 centimetres from the base frame and nail it. On the front side, place 2 nails, each 8 centimetres from the centre of the hive. On a level with the nails, cut two small holes in the rubber, so the base part is pressed against the upper part when you fasten the rubber bands on the head of the nails.

Entrance holes - 0,6 centimetres to protect against predators.

Make 4 to 6 entrance holes in the long side of the hive, approximately 0.6 centimetres high by cutting the cane weaving on the center of the hive. 2 centimetres above the bottom frame.

Fig. 3.13 Cut two strands of cane to make the entrance

Make the entrance holes on the same side as the base part is hinged. Then the open base part will meet bees returning to the hive, when you inspect it.

How to hang the hive.

Press a piece of wire through the cane weaving right under the top frame in each corner of the hive. Bend the wire like rings. Pull the string through the rings when you want to hang the hive. Secure the hive against wind by using short and tight strings

Fig. 3.14 Do not make the strings as loose as here

Coating the hive.

Fig. 3.15 Coating with Albizzia amara, rice husk and water

Pick 10 unripe fruits of *Diospyros peregrina*. Crush them in a rice husker and soak them in half a bucket of water for half an hour. Mix the liquid with rice husk and cover the outer surface of the hive with approximately 0.5 cm of the mixture. Let it dry in the sun for one day.

Dried and pounded leaves of Albizzia amara can be used instead of Diospyros fruits

The coating will protect your hive against rain and make it difficult for wax moths and other predators to enter the hive.

Coating the inner side of the hive with clay.

Mix some clay with water, so it becomes like thin porridge. Cover the inner surface of the hive with the mixture. Be careful to seal all cracks and make the surface smooth and plain. The clay coating helps the bees to regulate temperature and humidity in the hive and leave no place for wax moths to hide.

Fig. 3.16 Be meticulous when coating with clay so wax moths can find no place for hiding

When you hive a new colony; use the clay coating to cover all holes and cracks that may serve as false exits, and a queen gate in front of the entrance to prevent absconding.

Top bars

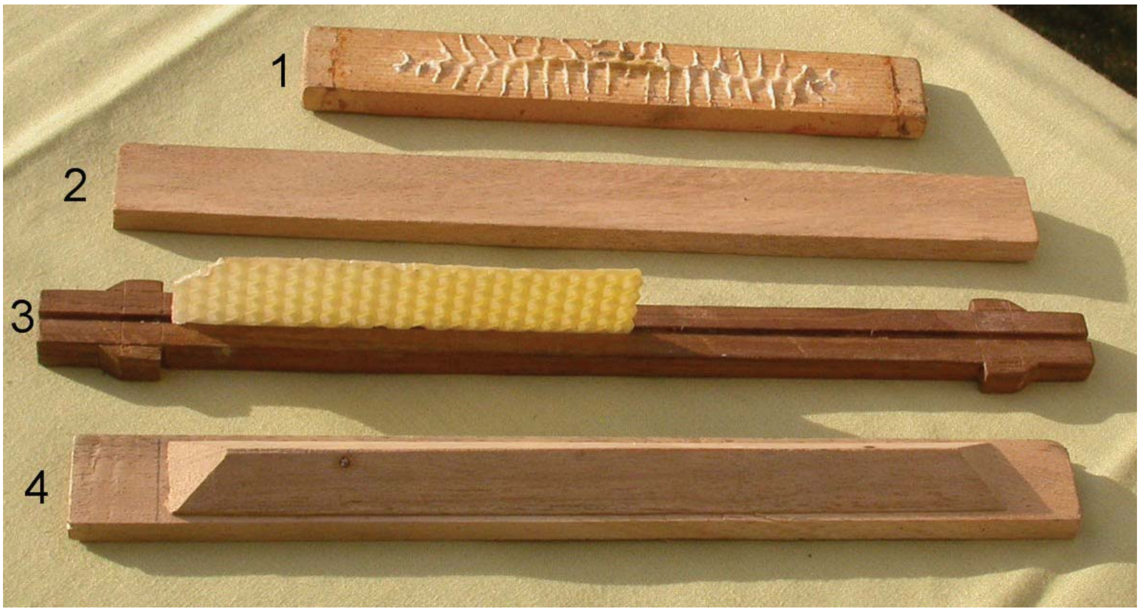


Fig. 3.17 Any of the top bars or combinations between the designs can be used

Making the top bars you have to work very accurate. Use a good quality of well-seasoned wood. The top bars must be exactly 2,54 centimetres (one inch) wide to give the bees the natural spacing for building one comb on each top bar.

Any of the top bars or combinations between the designs can be used. No. 3 is for multi-storey boxes because it will let the bees pass. If comb foundation sheets are used make a grove as in no. 3. No. 4 give a larger area to attach the comb, but it is time consuming to make it

Before using the top bars, smear them with bees wax. Right before hiving the bees you can rub the top bars with fresh lemon leaves. The scent of lemon leaves is said to attract bees.

Top cover

Use a piece of tin sheet 53 centimetres long and 34 centimetres wide. Make a cut 4 centimetres long in each corner towards the centre. Bend the sheet between the cuts to make the eaves and fold the corners as shown in detail.

Fig. 3.18 Details of the corner and eaves of the top cover

Chapter 4: Selecting a place to keep beehives

Fig. 4.1 A well protected apiary near a beekeepers hous in Vietnam. Notice the palm leaves used as shade for the hives

The most obvious place for a beekeeper to put the bees is near the house. This implies the following advantages:

It is easy for the beekeeper to follow colony development, manage and protect the colonies.

It reduces chances of theft of honey or beehives by humans.

It may reduce attacks from larger predator such as bears, honey badgers or monkeys.

In village areas there are often pollen and nectar sources, such as fruit trees and kitchen gardens. Floral diversity may be better than in agricultural areas.

Wherever bees are placed there should be:

Abundant nectar and pollen sources

Shade - to protect against high temperatures

Fresh water available

Protection against disturbance from animals and people

Protection against smoke from open fire

Wind breakers if high winds occur in the area

No heavy spraying with insecticides

Protection against ants and other pests

Nectar and pollen sources

Before placing hives in any location, it is important to get an assessment of the density and quality of the nectar and pollen sources – and the distribution throughout the year - in this specific area.

The density and quality of nectar and pollen sources will determine how many colonies can be kept in the area, or whether beekeeping is feasible at all in the area. This is called the carrying capacity of the area.

The distribution of nectar and pollen sources throughout the year will determine when honey harvest can be expected, also if the bees will have to be fed with sugar and pollen substitutes.

Foraging Range is the distance from the hive within which bees usually collect nectar and pollen.

Even though *Apis cerana indica* may forage up to 6-700 meters away from the hive, the efficient foraging range is probably only about 300 - 400 meters. When bees are foraging up-hill on steep slopes the foraging range is less. Because of the limited foraging range *Apis cerana indica* is extremely dependent on sufficient floral sources - throughout the year - within 300 – 400 meters from the hive. If flowers are not available, the bees must be fed with nectar- and pollen substitutes/supplement to prevent absconding.

The figures are valid for *Apis cerana indica* in tropical and sub-tropical areas. Because of a correlation between body size and foraging range, figures can be different for *Apis cerana* subspecies in temperate regions.

The assessment of floral sources will have to include all cultivated crops, as well as trees, shrubs and herbs.

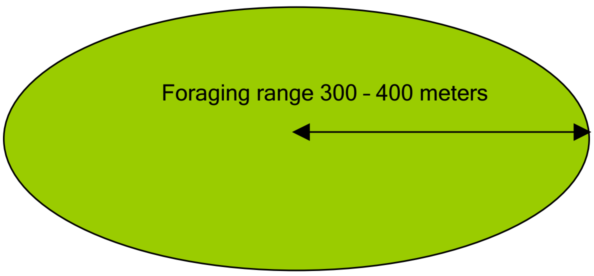


Fig. 4.2 Identifying nectar and pollen sources requires local knowledge

How to do a survey of floral sources

Fig. 4.3 A survey of the local flora will provide facts about nectar and pollen sources

Always find out whether the place where you want to place your beehives, is suitable place for an apiary. You will have to assess – and list in the form below - the floral sources within a distance of 300 meters from where you want to place beehives. Divide the circle into four equal parts by pointing out east, west, north and south. From the centre chose a point further than 300 meters away, and walk straight 300 meters (steps) in that direction. When you have reached 300 meters, turn around and walk back to the apiary site, while you list all nectar and pollen sources on both sides of your path. Do this in all four directions.

When you have finished the survey, place the floral sources in 12 groups (January to December) according to the month of flowering. Make a floral calendar, estimate the quality of the sources, and find out when honey harvest can be expected, and when to feed the bees.

Consider the important influence of climatic conditions.

Table 6 Assessment of Nectar and Pollen sources

Local name	Botanical name	Month(s) of flowering	Rating of nectar (1-5)	Rating of pollen (1- 5)	Presence in area (1-5)

(Rating: 5 is maximum. 1 is minimum)

Area: *Signature:* *Date:*

Table / gives an example of a floral survey. Only the trees found with in 400 meters are shown. Shrubs and herbs should also be included.

ASSESSMENT OF NECTAR AND POLLEN SOURCES

AREA: XXX Southern India DATE: SIGN:

Botanical Name	Local Name	Months of flowering	Rating of nectar	Rating of pollen	Presence in area
TREES					
Abutilon indicum			5	2	1
Acaccia planifrons			2	5	3
Acacia auriculiformis	Pencil		1	5	1
Acacia nilotica	Karruval		1	5	5
Acacia nuriculiformis			5	1	3
Albizzia amara	Usil	12	2	4	5
Albizzia lebbeck	Vagai	9,10,2,3	2	4	1
Azadirachta indica	Vambu	03-04	4	1	1
Bauhinia purpurea	Manthari	10-01	3	2	3
Bauhinia recemosa	Aatthi	09-10	3	1	5
Borassus flabellifer	Panni	03-04	1	5	1
Carica papaya	Pappali	01-12	1	5	5
Carissa carandas					1
Cassia fistula	Sarrakonnai	10-11	1	5	4
Cassia siamea	Manjakonnai		1		1
Ceiba pentandra	Illavam	12-01	3	2	1
Cochlospermum gossypium	Thannakkamaram				1
Cocos nucifera	Thennai	01-12	1	5	4
Dalbergia sissoo	Sissoo	02-03	3	1	2
Delonix regia	Alangaraikonnai	03-04			1
Ehretia laevis					4
Emblica officinalis	Nalli	11-12	4	3	1
Eucalyptus globulus	Eucalyptus	02-03	2	2	1
Gliricidia sepium	Veevasayathakarai				1
Leucaena leucocaephala	Subba		2	5	1
Mangifera indica	Mango	01-03	2	3	2
Melia compostia	Malivembu	09-10	2	2	2
Millingtonia hortensis	Panneer				1
Moringa concanenlis	Murungai				
Moringa pterigosperma	Kattumurungai	10-02	2	2	1
Peltoforum ferrginum	Aayalvagai	03-04	1	5	1
Pithecolobium dulce	Kodikkapulli	02-04	2	3	1
Pongamia pinnata	Poongam				5
Prosopis juliflora	Seemakaruvall	03-05	3	3	3
Psidium gujava	Kooya	09-10	3	3	5
Samanea saman	Dungumoonchi				3
Sapindus emarginatus	Poonthikottai		2	2	
Sysygium cumini	Naval	04-05	2	2	5
Tamarindus indica	Pulli	11-12	2	2	1
Tectona grandis	Takku				5
Thespesia populnea	Poovarusu				5
Zizyphus jusupa	Illanthai				1

Chapter 5: How to obtain colonies

Buy colonies from another beekeeper

Capture of swarms during the swarming season

Capture of feral colonies

Division of colonies

A crucial point in any beekeeping activity is a steady supply of new colonies; not only in the initial phase to establish a beekeeping operation, but also to increase the number of hives or replace absconded or diseased colonies.

There are rarely options for buying bee colonies and beekeeping with *A.cerana indica* on the Indian subcontinent is to a great extent based on capture of feral colonies. Compared to producing colonies via queen rearing depending on feral colonies has a number of disadvantages.

Capture of feral colonies

Seen in an environmental perspective it is not sustainable to base beekeeping with *A.cerana* on capture of feral colonies. Trees and bees are often damaged during capturing. Nesting places are frequently destroyed, and – using conventional technology and management - less than 10% of colonies remain in the hive after two years. Beekeeping projects based on capture of feral colonies tend to cause environmental damage by emptying whole areas for feral colonies. Pollination of cultivated crops and wild flora may be affected.

Apart from the environmental damage, capture of feral colonies is time-consuming and the least cost-effective way of getting new colonies.

Fig. 5.1 A tree damaged by capturing of a colony

Women are often - for cultural reasons – not supposed to climb trees or cliffs to capture colonies. The dropout rate among women is often high because they have no options to get hold of colonies.

Capture of feral colonies can indirectly lead to selection of bees with a high tendency of swarming/ absconding and unknown ability to produce honey.

With conventional hives and management techniques an average of 33% of colonies abscond every year, increasing the need to capture more feral colonies.

When colonies are not available the dropout rate of trainees in beekeeping projects is often very high. In a cost-benefit perspective, overall economy becomes poor. Often more than 50% of investments in infrastructure and training give no returns because of empty hives.

Requeening of captured colonies is not a common management procedure. Colonies with old, less productive queens often swarms and yields little honey.

Regarding production of colonies and requening see chapter 10

Chapter 6: Inspection of hives

Two basic rules when opening hives:

Know what you are looking for and why

Disturb the bees as little as possible

Fig. 6.1 Take time to observe the hive from outside

Fig. 6.2 Bees are trying to reduce the temperature in the hive by fanning

Observing the hive

Observing the hive from outside can tell you about what is going on in the hive. With a little experience it is easy to tell if the flight activity is normal with the usual number of nectar- and pollen collectors coming in. Remember the foraging activity is bound to the nectar secretion and availability pollen in flowers and will have a peak time when there is maximum forage to collect.

It is useful to pay attention to the following:
Bees approaching the hive with their hind legs hanging are bringing in nectar. If bees are working steady to bring in pollen and nectar, there are usually no major problems in the colony.

If a large number of bees are coming back with their pollen basket full, probably brood rearing in the colony is increasing.

Fighting between guard bees and a few foragers is usually because the foragers did not return to their own hive. The foragers will try to bribe the guard bees with nectar to get into the hive.

If a large number of bees are fighting at the entrance probably a stronger colony is trying to rob a weaker colony of its honey stores. It can be necessary to block the entrance in all colonies involved in the robbing until the next day. It may also help reduce the entrance of the colony being robbed; so only one bee can pass.

Too high temperatures inside the hive often cause a lot of bees clustering outside the hive with very little flight activity. Improve shade and if possible increase space in the hive.

During the initial stages of absconding or swarming a lot of bees may cluster outside the hive. Flight activity will be high and there will be at lot of movement in the cluster. Immediately splitting the colony into two hives preferably with caged queens or better with ripe queen cells will usually help. The new hives should be placed about 1 kilometre away from the old place.

A few dead bees on the ground outside the hive are often dead foragers cleaned out by the house bees.

If there are a lot of dead bees outside the hive - often with their tongues stretched – insecticides may have poisoned the colony. Poisoning often happens during foraging in near by fields, which have been sprayed. Surviving bees may fight at the entrance. If there are sufficient surviving bees in the colony close the entrance with wire mesh immediately to prevent the survivors from being poisoned. A wet gunny bag over the hive will help to keep temperature down.

Fig. 6.3 A colony preparing to swarm

Fig. 6.4 Notice the position of the tongue if poisoning is suspected

Around noontime a lot of young bees can be seen hovering in front of the hive. It can be mistaken for the initial stage of swarming or absconding, but is only young bees out on orientation flights. It is often called play flights. The bees will return to the hive after some time.

If dead larvae are found outside the hive the colony is probably attacked by disease. Often it is a sign of a severe attack of Thai Sac Brood Virus.
The presence of capping from drone cells outside the hive indicates drones are emerging. Swarming could be happening soon. Combs should be checked for swarm cells.
Pests and predators such as ants, wasps and bee-eaters can easily be observed from a distance.

Attacks from ants (Fig. 6.6) and wasps (Fig. 6.5) can cause absconding very fast

Fig. 6.5

Fig. 6.6

Before opening the hive


Fig 6.7 Protective gear can make you feel more comfortable

Wearing a loose fitting, light coloured or white dress is an advantage. Dark clothes will make the bees sting more. For women wearing saris an anorak with veil can be useful in case protective gear is needed.

Only neutral soap should be used before working with bees. Strong scents, perfume and body odours - like sweat - can cause stinging.

Do not hesitate to use a bee veil and gloves or other protective equipment if it makes you feel more relaxed. It is important to feel comfortable when working with the bees.

Avoid opening the hive on rainy or windy days. Approaching thunderstorms will also make the bees more aggressive.

In areas where it will be very hot at noontime early mornings or very late afternoon is often a suitable time to open the hive because temperature is lower.


Fig. 6.8 Taking a colony apart like this may cause absconding.

Average colonies of *Apis cerana indica* are usually docile to handle. Bee veils and gloves are rarely needed.
Very strong colonies can be quite aggressive. Protective equipment is recommended to be able to work without being harassed by the bees.

If you get stung scrape the sting away with a fingernail or a knife without squeezing the poison sac. Rub the skin with crushed leaves to camouflage the alarm pheromone. Otherwise other bees will be alerted and start stinging.

Unusual conditions in the colony can make the bees more aggressive. For example if the colony is queen less, have laying workers due to an old queen, is preparing to abscond, is being robbed by other bees or if there are no pollen and nectar sources. Attack by large predators such as bears can make the bees aggressive for several days.

Direct sun on the open hive or combs should be avoided.

Smokers are of little use with *Apis cerana indica.* If smokers are used only very light smoke should be applied. Using heavy smoke can easily make the bees more aggressive and cause absconding.

Because *Apis cerana indica* is not using propolis, as Apis mellifera, there is no need for heavy hive tools when opening the hives. A slim knife made from a sharpened piece of hacksaw blade will be handier and can be used for cutting and uncapping combs.

When working with *Apis cerana indica* it its very important to work gently and with great care. Avoid squeezing bees. Rough handling or taking the hive apart too often is stressing the bees and may cause absconding

Fig. 6.9 Be care full not to squeeze any bees

If you hear a hissing sound and see like a wave movement in the colony, it is because all bees are on alert. In some colonies you can even smell the alarm pheromone. Then take extra care bees may be quite aggressive.

If you need to remove the bees from a comb do not try to shake the bees of. Shaking combs will give a lot of bees in the air. Hold the comb near the opening between the frames and tap lightly on the top bar until the bees start walking into the hive.

What to look for:

- **If honey and pollen stock is sufficient**
- **Strength of the colony**
- **If eggs are present, if only one in each cell there is no need to search for the queen**
- **If all combs are covered with bees**
- **If more than one egg in each cell, laying workers are present. Check if the colony is queen less**
- **Brood combs, is the brood area increased or decreased**
- **Check for drone cells**
- **Check for queen cells**
- **Signs of disease, particularly TSBV**

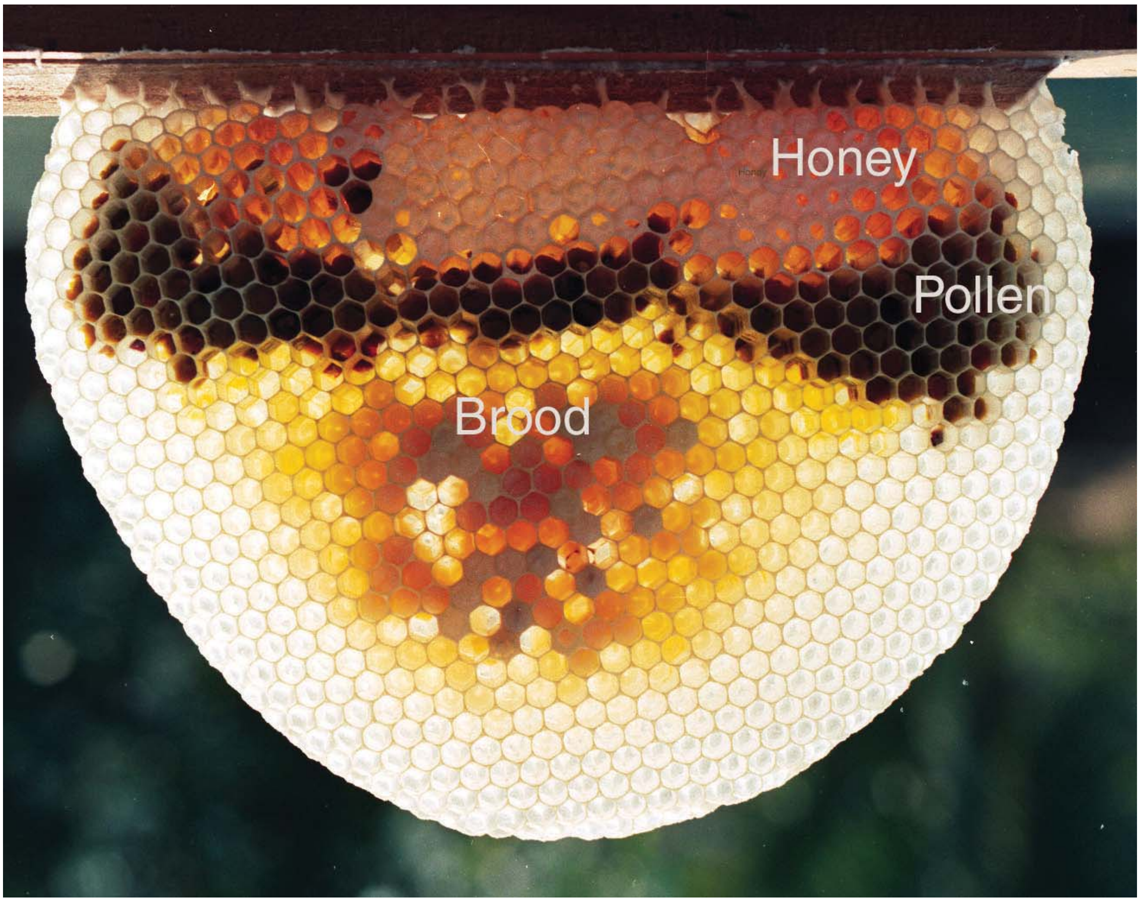


Fig. 6.10 A comb with abundant pollen and honey

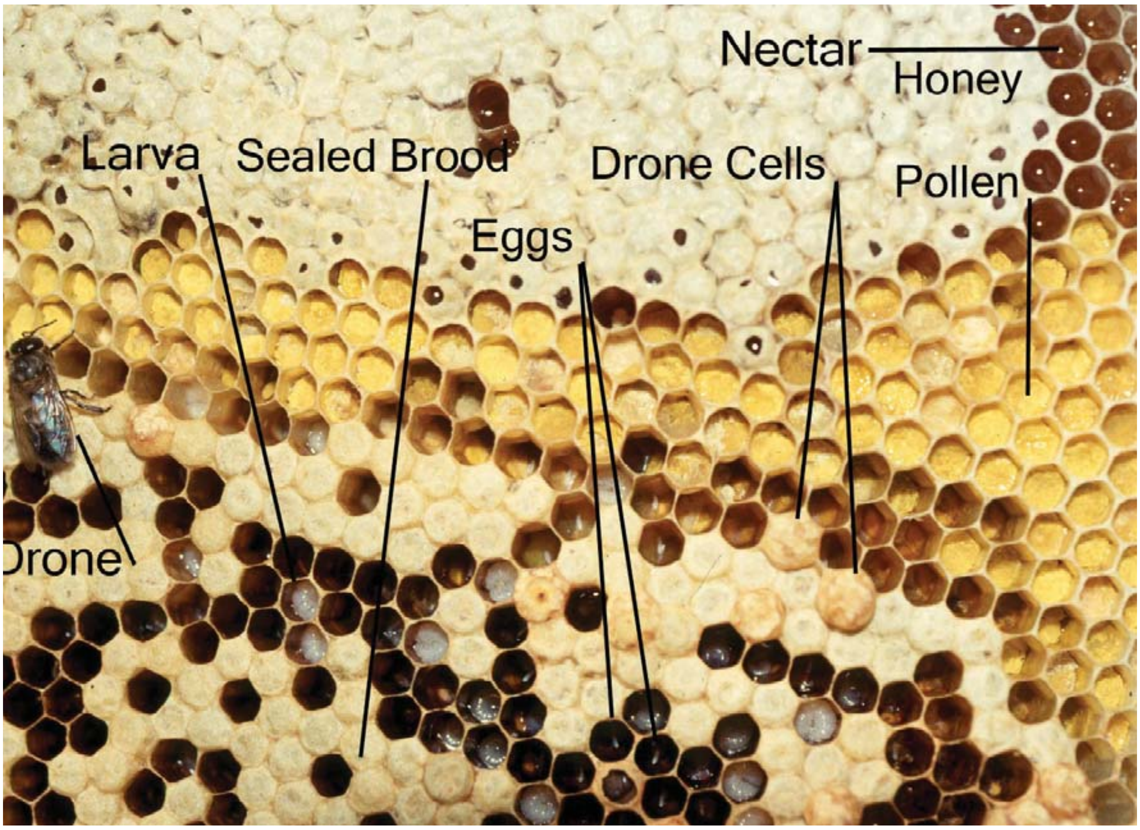


Fig. 6.11 The basics of the comb

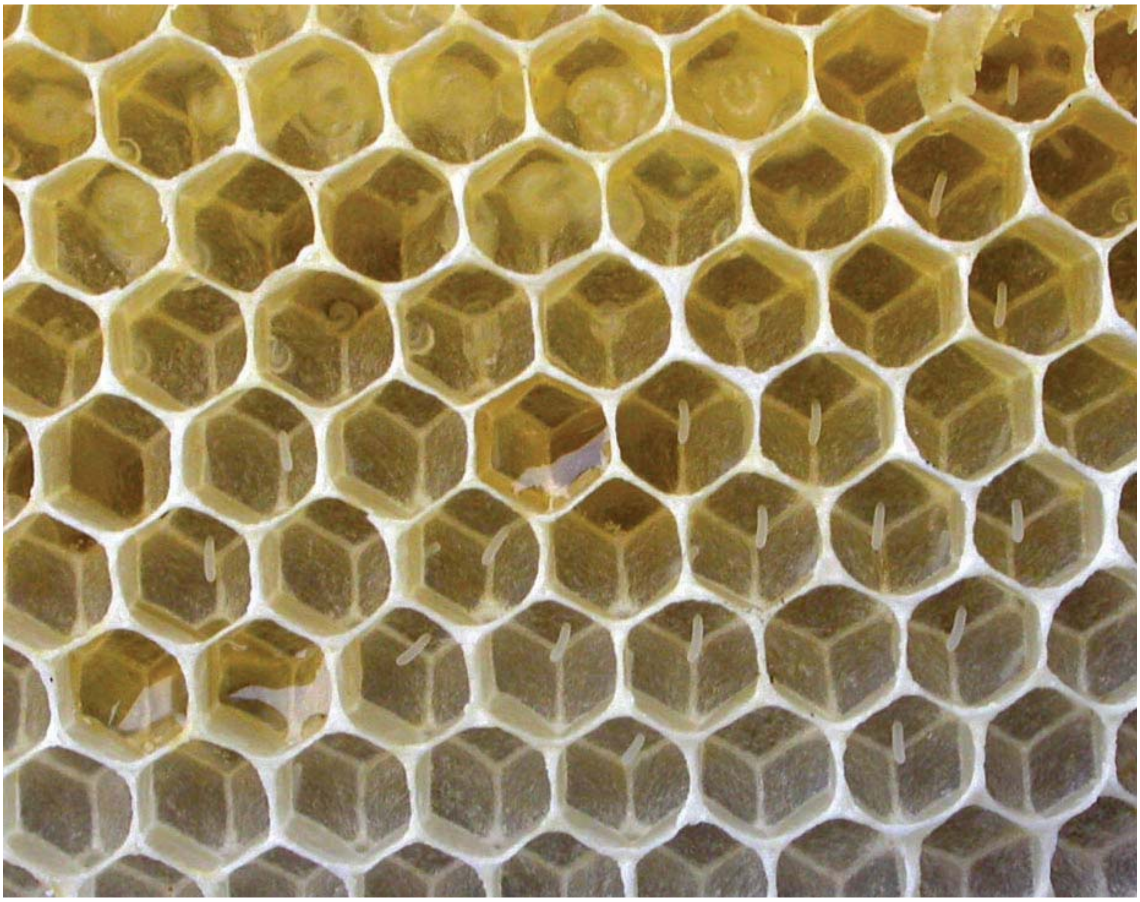


Fig. 6.12 A normal pattern of eggs and larvae

Fig. 6.13 Characteristical symptoms of Thai Sac Brood Virus

Working with frame hives

Fig. 6.14 Use a handkerchief to keep most of the bees inside the hive

Remove the hive cover and place it upside down on the ground

If a super is there turn it a little sidewise, lift and place it (with the top cover) on the hive cover

Use a handkerchief to cover the frames. It will keep most of the bees in the hive. Also keep any supers covered.

Start by taking out the second comb to make space to move the combs in the hive. Place it upside down on the ground

Move the next comb a little so you get space to take it out without squeezing bees. Continue until all combs are checked.

When replacing combs make sure it is to the original position in the hive.

Remove the brood box and clean the bottom board for any wax debris to prevent wax moths from breeding there

Fig. 6.15 Notice the comb is kept near the entrance bees will start walking inside

Working with top bar hives

Fig. 6.16

Fig. 6.16 & Fig. 6.17 No disturbance and no bees in the air when inspecting from below

Most inspection can be done from below without disturbing the colony. With a little experience it is easy to see if there is something unusual going on in the colony. In case of doubt open the hive cover and take out a few combs for inspection.

During the swarming season it can be necessary to check all combs for queen cells.

Fig. 6.17

Fig. 6.18 Inspecting a pottery top bar hive

Keeping records

Fig. 6.19 Keeping records is a way to learn more about bees

When the number of hives increases it becomes more and more difficult to remember what has happened with the individual colony during the year. Keeping written records is a way to improve efficiency, because last years records will help in planning for the coming year. Records from only a few hives will show patterns of what to expect during different seasons.

If the aim with your beekeeping is queen rearing or breeding, records is a necessity for selecting the best colonies. The difficult balance in keeping records is to find the appropriate level of information needed in the future. Taking too many notes is time consuming but it is also annoying to miss out information that can be of value in the future. Hive cards should be designed so they serve the specific purpose of keeping the records.

Below is shown a hive card serving most general purposes. Measuring the area of different types of combs can just be left out if it serves no purpose in the situation. In case of queen rearing or selective breeding information about docility, tendency to swarm, abscond or migrate as well as disease tolerance should be added.

Table 8 Hive Card

Hive Card: Apis cerana indica					PLACE:		HIVE:	HIVE NO:
Date/Sign.	/	/	/	/	/	/	/	/
Total no of combs								
Cm2								
Brood combs								
Cm2								
Empty combs (cm2)								
Super/honey combs (cm2)								
Pollen 1-5*								
Nectar 1-5*								
Eggs								
Laying workers								
Larvae								
Pupae								
Drones								
Queen cells								
Feeding								
Predators								
Combs removed								
REMARKS Date:	Captured	Division	Queen rearing	Absconded	Absconding caused by:		*5 = Highest rating. 1 = Lowest rating	

Chapter 7: When bees leave the hive

One of the most disappointing situations for a new beekeeper is when the bees suddenly leave the hive.

If all the bees leave, it is either absconding or migration. Since the trigger factors, causing the bees to leave, could be almost the same it can be tricky to differ between absconding and migration. Among beekeepers the term “absconding “ is commonly used even when it actually is migration. If not the whole colony has left and some bees along with a queen - or queen cell - still remains it is called swarming.

Absconding

Fig. 7.1 Are the bees still there?

Absconding is a strategy for survival. The bees will respond to a serious threat to the continued existence of the colony by shifting to a new place. Absconding is often triggered by external factors, such as lack of forage or feeding, the use of less appropriate hives, diseases, unfavourable climatic conditions and disturbance by predators. Beekeepers are unintentionally - but frequently - causing their bees to abscond by repeatedly taking apart the whole colony, to inspect the bees or to show it to visitors.

Absconding/migration can be a serious obstacle to profitable beekeeping with *Apis cerana indica*. With the commonly used Newton hive and the generally used management methods, approximately 33% of the colonies will abscond/migrate in a year.

The loss can be reduced to less than 10 % using more appropriate hives and management methods. Further reduction probably requires a selective breeding programme. The tendency to abscond differs widely between colonies, making fast progress in selective breeding possible.

Migration

Migration is the bee’s response to a temporary chance in climate and availability of nectar- and pollen sources in a certain area.

In hilly areas it is often easy to observe patterns of migration in feral colonies. Before the onset of the monsoon in the upper areas of Palni hills or the Nilgiris in western Tamil Nadu unknown factors will trigger a substantial part of the dark hill bees to migrate to lower areas. (There is a distinct difference in colour between the dark bees in the hills and the yellow bees in the plains). When the weather improves and the flowering season start the bees will return to the higher altitudes.

Fig. 7.2 A newly arrived colony

Fig. 7.3 A swarm temporary settled in a tree until a new cavity is found

Feral colonies in “weatherproof” places - like cavities in cliffs - and colonies with abundant storage of nectar and pollen will rarely migrate from the upper areas.

As cold and rainy weather with high wind velocity will make the hill bees leave for less harsh places, also very hot and dry weather can trigger migration. The yellow bees of the plains migrate for some time to the lower areas of the hills, when the plains become too hot and dry along with less sources of nectar- and pollen.

It seems the two populations of bees meet at an altitude of 500 to 700 meter, although it is possible to find yellow bees above and dark bees below the line.

In some areas of the hills 1 to 5 % of the total bee population differs in colour from the dark hill bees, looking more reddish. It appears that these red bees forms larger colonies and are less likely to abscond or migrate.

Swarming

Bee colonies send out swarms to multiply and secure the overall survival of bees in nature. Normally swarming takes place during more or less well defined swarming seasons. Some of the trigger factors for the swarming impulse are:

Colonies crowded with young bees after a period of rapid growth.

Little space available for building newcombs in the hive

Abundant nectar- and pollen sources

Conducive weather – e.g. swarming will usually not take place during very hot, cold or rainy periods.

For the beekeeper the first sign of a colony could be preparing to swarm is drone cells appearing on the combs. Next the bees will start drawing queen cells – called “swarm cells”- in the lower part of the combs. The presence of a number of sealed queen cells usually indicates swarming will take place. If the foraging bees stop their flight activity during periods of the day when they typically forage, swarming may take place at any time.

When the first swarm issues the old queen together with a varying number of adult bees will leave the hive and settle in a cluster nearby. Scout bees will have located cavities suitable for the new colony to inhabit and try to communicate the locations by dancing. After some time the swarm will take of and settle in a new cavity.

Chapter 8: Production of honey

The presence, abundance or absence of bee plants during the year, determines - presupposed the beekeeper does not interfere - the size of bee colonies and their honey yields. *Apis cerana indica* worker bees usually forage within 300 to 400 meters of the colony. The closer forage is to the colony, the less energy and time bees needs to collect nectar and the more honey can be harvested.

Like any yield from plant based production, harvests of honey vary from year to year, vary from beekeeper to beekeeper, and vary from one area to another. Generalizing and quantifying the yields is difficult because several factors influence the outcome:

Factors influencing honey yields

The enviroment and bees used

The density and quality of the nectar and pollen sources within the foraging range of the bees

The skill of the beekeeper

The choice of technology and management methods

The weather

Possible attacks of predators or diseases

Fig. 8.1 Honey is a high value product in most rural areas

Environment and honey production

Bees store honey to survive during periods where no, or little, nectar is available (dearth periods). There is a strong correlation between the quantities of honey the bees store up and the environment to which the bees are adapted.

To survive the cold winter in the mountains of Himalayas colonies of *Apis cerana cerana* can stock up 10 – 15 kilo of honey.

In the tropical and sub-tropical parts of the Indian sub-continent Apis cerana indica colonies need much less storage for survival because the climate facilitates flowering of pollen and nectar sources throughout the year.

For a beekeeper working with captured feral colonies of Apis cerana indica this means a serious limitation to the honey yields that can be expected. The average honey harvest from well-managed colonies kept in Newton hives will usually not exceed 2 – 6 kilo honey per year.

Harvesting honey

Fig. 8.2 Uncapping of honey before extraction

Honey is usually ripe to harvest when the bees have capped more than 70% of the area with honey. It is important not to harvest until the content of moisture in the honey is low. A high content of moisture will make the honey ferment fast. The average moisture content in honey from *Apis cerana* seems to be higher than in honey harvested from *Apis mellifera*.

A high level of hygiene is important during honey harvest. Clean all vessels, honey extractor, uncapping knife and honey storage containers thoroughly and let it dry before starting the harvest. Honey is hygroscopic and will absorb any water left on the utensils. Do not forget to wash your hands. Any dirt or moisture will make the honey ferment fast.

In multi storey box hives the bees will store excess honey on top of the brood box. In top bar hives the honey is placed on both sides of the brood combs like in feral nests. If sufficient space is left over the top bars bees may build honeycombs above the top bars. This principle is to some extent used in beekeeping with *Apis cerana cerana* in Vietnam.

Do not harvest honey from combs containing brood. The bees will need the honey to feed the brood or for the whole colony if no nectar is available.

Apis cerana indica is surprisingly docile during honey harvest. Uncapping of combs and extraction of honey can take place close to hives with only few bees around. Honeycombs from frame hives and top bar hives have to be uncapped before extraction. Uncapping is to remove the thin layer of wax sealing on the cells.

The best way to harvest honey from fixed comb hives is to cut the comb into small cubes and leaving it to drain in a piece of cheesecloth. Draining honey works best if temperature is above 20°C. The alternative is to squeeze the honey out by hand.

Fig. 8.3 Honey combs build above the top bars

Fig. 8.4 Two stages in honey harvest in a log hive with space for honey above the top bars

Honey extractors

Conventional extractors

Fig. 8.5 Conventional extractors are only suitable for combs supported by a frame

Fig. 8.6 Uncapping the honey comb before extraction

Fig. 8.7 Returning the empty combs to the hive

A multi purpose extractor for top bars as well as frames

Fig. 8.8 Testing the multipurpose extractor

A limiting factor for use of top bars in *Apis cerana indica* hives has been the lack of suitable extractors.

Combs on top bars require to be placed horizontal and the top bar supported to avoid breakage of the comb. In this position the cell structure of the comb can withstand much more centrifugal force when rotated in the extractor. Frames with honeycombs can be extracted using the same principle.

Since it is too inconvenient to use different extractors for frames and top bars a multipurpose extractor is the better choice

The design shown here was developed by the Author and Palni Hills Conservation Council South India to fit with the size of top bars and frames used in a *Apis cerana indica* beekeeping project with. With a few alterations it can be adapted to any size of top bars or frames.

The diameter of the inner basket and outer drum is determined on basis of the length of the top bar or frame and the depth of the comb.

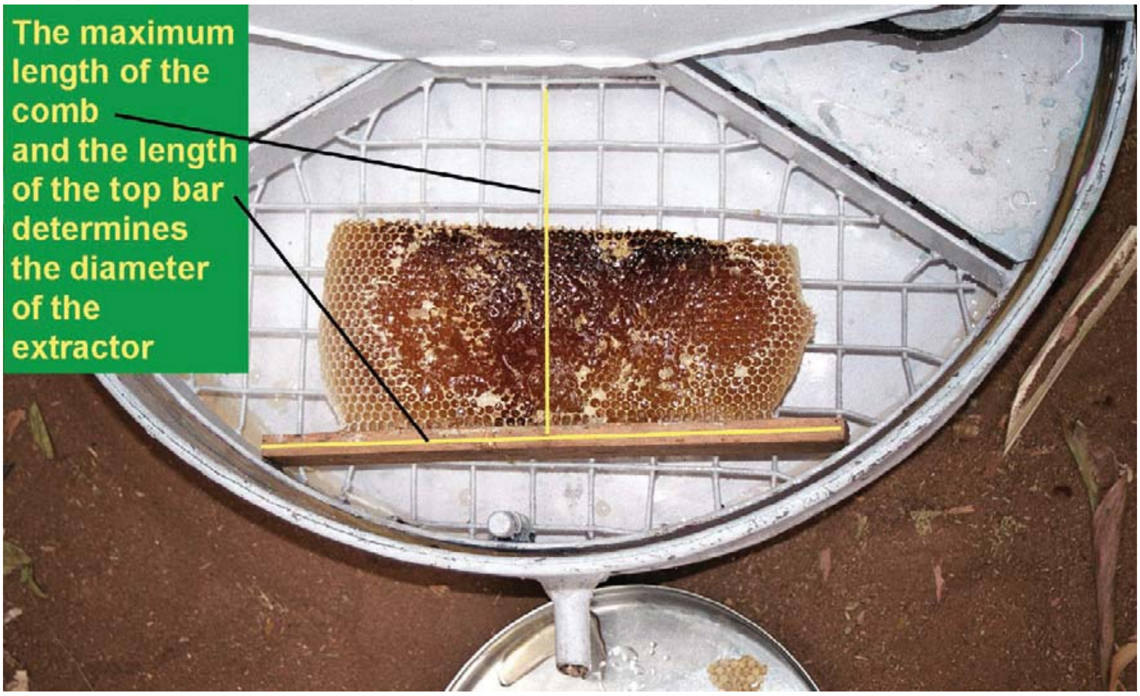
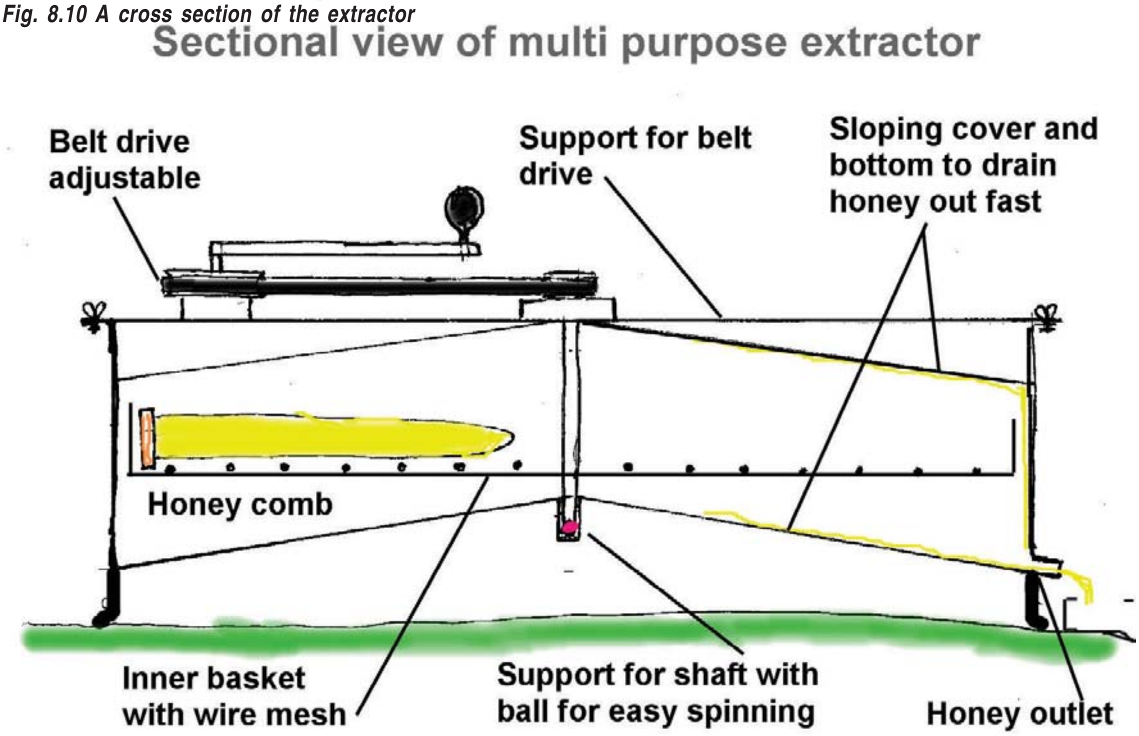


Fig. 8.9 Factors influencing the diameter of the extractor

The speed of rotation is dependent on the difference in size between the two V-belt pulleys. Radial extractors like this should be operated at a lower speed – but for longer duration - than conventional extractors.

Fig. 8.10 A cross section of the extractor



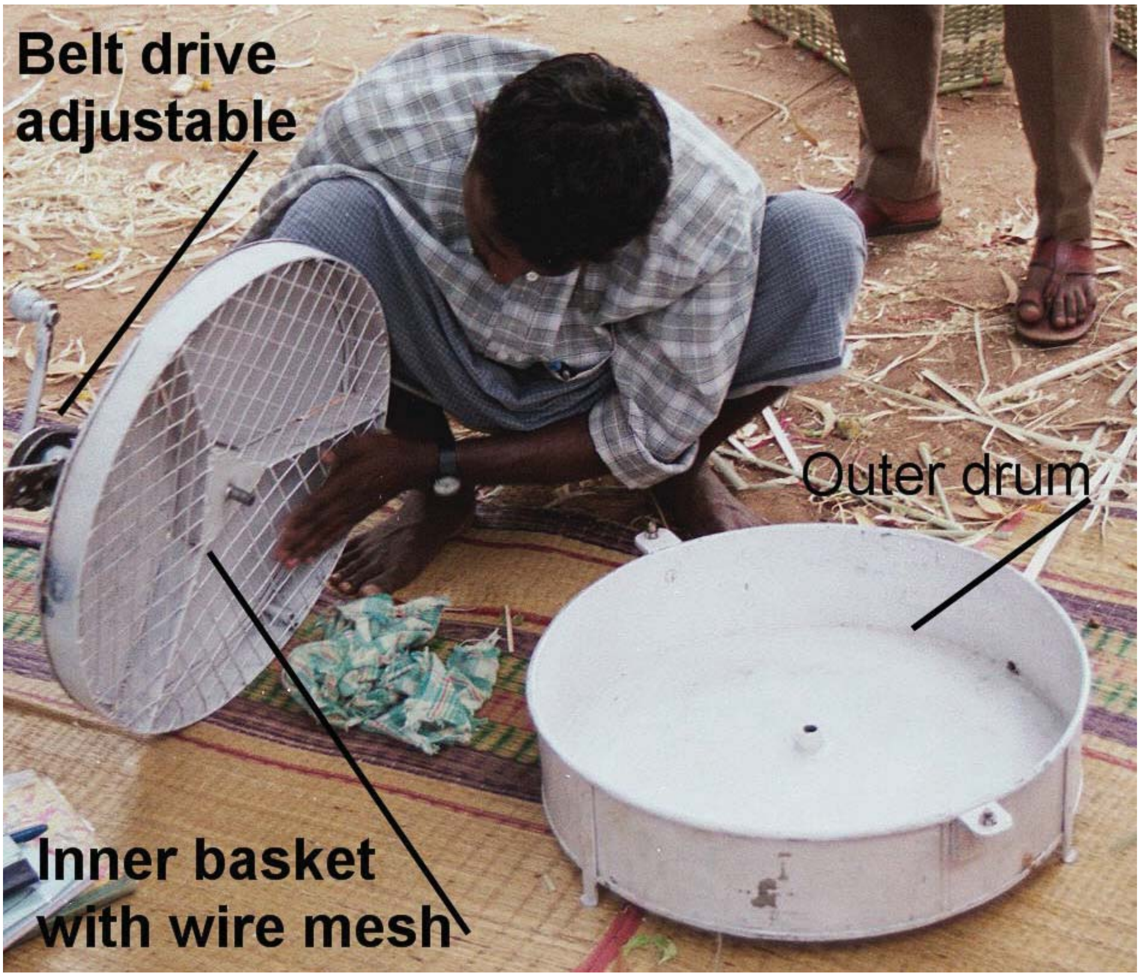


Fig. 8.11 The two main parts of the extractor

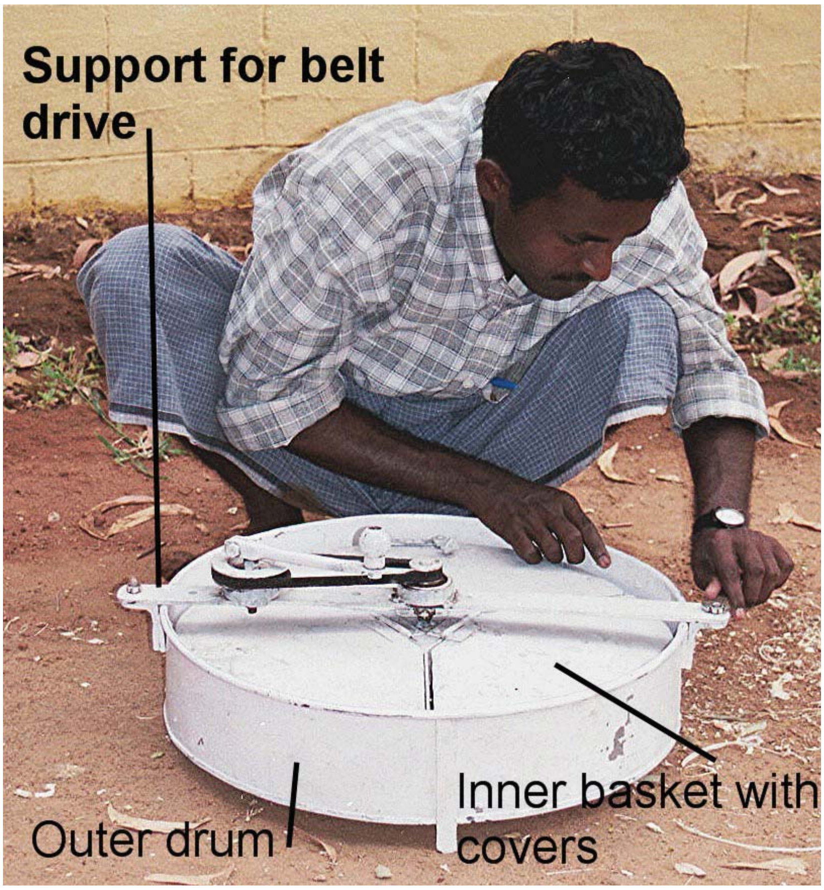


Fig. 8.12 A view of the extractor closed

Fig. 8.13 A view of the extractor open

Chapter 9: Feeding bees

Fig. 9.1 Feeding bees is an essential management tool

Feeding with sugar and pollen substitutes is a essential management tool in *Apis cerana* beekeeping. By feeding the beekeeper can influence the size of colonies and the number of bees in different age groups at a certain time. Feeding will increase the number of bees in a colony, because the bees respond to sugar feeding by rearing more brood. Feeding can bring colonies safe through dearth periods and – to a large extent – prevent absconding. Monsoon season is a dearth period when the bees' food sources are scarce.

If a beekeeper harvest all the honey from a hive, feeding the bees sugar is necessary to replace the lost food reserves. Failing to provide for the bees can cause the colony to die from hunger or abscond the hive.

Feeding the bees is important:

To increase the size of colonies before expected heavy nectar flow

To increase the size of colonies before a colony multiplication/queen rearing programme

To suppress absconding caused by scarcity of nectar and pollen during dearth periods

When only little pollen and nectar is found in the hive

After capturing a new colony

After transfer of a colony to a new hive

When dividing a colony

If honey is harvested at a time when nectar flow is limited

What to feed to the bees?

Honeybees need to collect both nectar and pollen to fulfil their nutritional requirements. When we start to feed with substitutes it is important to remember that both substitutes for nectar and pollen can be needed.

Let us first look at the substitute for nectar: Sugar feeding

A boiled solution of 60% sugar and 40% water can be used to feed the bees, but it is better to use Mulderry Syrup or Candy because it contains inverted sugar.

What is inverted sugar?

Bees collect nectar from flowers. The main sugar in nectar is sucrose, which is made up of a molecule of glucose and one of fructose. During the conversion of nectar to honey the bees adds the enzyme invertase (sucrase) to break down the sucrose into glucose and fructose.

The process used by the bees can be imitated by heating a solution of white sugar, water and lactic acid. - The processed sugar is called inverted sugar.

The use of inverted sugar probably saves the bees time and energy to process the sugar.

When offered a choice between a conventional sugar solution and Mulderry syrup the bees usually show a strong preference for the inverted sugar, if the content of sugar is the same.

Note: A poisonous side effect of acid inverted sugar has been reported when used for wintering Apis mellifera bees in cold climate. Used for feeding *Apis cerana indica* I have noticed no side effects of lactic acid inverted sugars.

Fig. 9.2 Kneading the candy

How to prepare Mulderry Syrup

Add 3,50 ml lactic acid to 1 litre of water and mix it with 2 kg sugar. Let it simmer for half an hour.

The easiest way to measure the exact quantity of lactic acid is to use a clean disposable syringe.
Warning! It is important to use the exact quantity lactic acid. Too much lactic acid or the use of other acids may harm the bees.

How to prepare Mulderry Candy

You will need the following ingredients:

1 litre of water
2 kg sugar
3.50 ml lactic acid.
Approximately 9 kg finely powdered sugar (Use a stone mill and ordinary sugar if you can't purchase it ready made).

Use the same procedure as for making Mulderry syrup and when the liquid is cold, mix 3 parts of finely powdered sugar with one part of the liquid. Knead it well until it is like dough for making bread. Fill 50 to 100 grams in small plastic bags and seal them with tape. Use sturdy plastic bags to prevent the candy from drying.

When you want to use the Mulderry Candy, put one bag in a beehive and cut it open with a knife. Do not remove the plastic. The plastic will for some time keep the candy soft, making it easier for the bees to collect the candy.

In frame hives the plastic bag is placed upside down op top of the frames.

In Mulderry hives the plastic bag can be fixed with a pin to the bottom of the hive. This will prevent the bag from falling when the bottom part is opened for inspection.

What not to feed the bees

Feeding bees with molasses should be avoided because this can cause dysentery like symptoms: Brown spots of faeces inside and near the entrance of the hive.

To use non-boiled honey for feeding involves the risk of spreading viral and bacterial diseases such as TSBV and AFB. Boiling the honey for 15 minutes reduces the risk of transferring diseases.

Use of white sugars with small particles of dirt or dust makes the syrup unsuitable for storing. It may become solid because of crystallisation

Feeders for Top Bar hives

Use the shell of a small coconut (or any container of the same size) drill four holes in it and drill a hole in the centre of a top bar. Use some wire to hang the container in one side of the hive. Do not obstruct comb building by placing the feeder too close to the combs.

Fig. 9.3 An old tin used as a feeder in a top bar hive

Do not forget to put some straw or leaves in the feeder when you use it, otherwise the bees will drown.

Disturb the bees a little as possible when supplying more syrup. Remove only two top bars next to the feeder, and pour the syrup gently into the container to prevent the bees from drowning.

Feeder for frame hives

Fig. 9.4 Coconut shells and fibre is useful for making feeders

Feed the bees in a container placed in an empty super on top of the brood chamber. To prevent the bees from drowning put some straw, coconut fibre or leaves in the feeder.

Problems when feeding

If there are weak colonies to be fed in an apiary, robbing by stronger colonies can be a problem. In case of robbing seal all cracks, which can be used as an entrance with mud or cow dung. Reduce the entrance to the hive to a size where only one or two bees can pass at a time. Use of a special feeder

can also help. Find a small (approximately 250 ml) plastic container with an airtight lid. Use a 1mm drill to make 5 holes in a circle close to the centre of the lid. Fill to one cm from the rim with syrup, place the lid and turn the container upside down. The vacuum will prevent the syrup from spilling out. Place the feeder on top of the frames in frame hives. In Top Bar hives use a piece of string to hang the feeder (upside down) next to the combs. Make sure the lid of the container is placed exact horizontally to avoid spilling. The bees will suck the syrup from the holes. If the plastic container is too smooth for the bees to get a foothold, rub the lid with a piece of sandpaper, or some fine sand.

Preparing sugar feeding from sugar or water contaminated with small particles of sand or dust may cause crystallization of the sugar solution. Use only non-contaminated water and sugar.

Fig. 9.5 Adding food colours to sugar syrup is a way to ensure it is not sold as honey

To secure sugar syrup is not extracted and sold as honey, the sugar – or the syrup, can be mixed with a red, blue or green food colour.

Ants are attracted by sugar syrup and candy. Make sure the ants are prevented from entering the hive.

Always feed bees inside the hive, to feed them in the open often causes robbery among colonies.

Some times it can be hard to convince beekeepers and even project staff to use sufficient sugar for feeding. In their conception, sugar may be for human consumption only, and too valuable to use for feeding bees. It is important to analyse and stress the cost/ benefit perspectives of feeding during training of beekeepers and project staff.

The importance of pollen

Pollen is the male germ plasma of plants and contains all the substances necessary to make up a living cell.

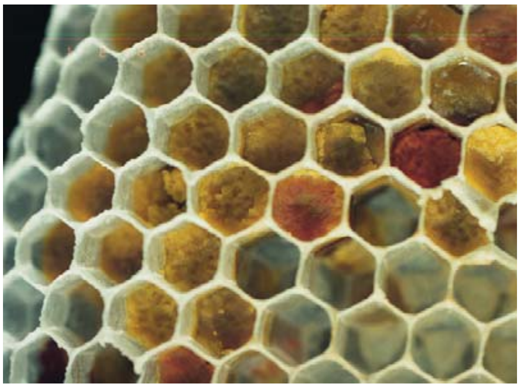


Fig. 9.6 Colours of the pollen give an idea about the sources

In the honeybee diet, pollen is the chief source of protein, vitamins, fats and minerals. The content of protein and other substances in pollen from different flowers varies widely.

If there is a high density of colonies in an apiary – the carrying capacity of the area of foraging has been exceeded - shortage of pollen can often be seen in the colonies. Pollen shortage is limiting factor to colony development and honey production. Acute lack of pollen can cause cannibalism (Adult bees eating egg, larvae and pupae), and finally death or absconding of the colony.

Other materials with a similar food value - a pollen substitute, can -at least partly - replace the need for pollen. Popular ingredients for pollen substitutes are soybean flour, dried yeast, dried fishmeal and dry skimmed milk powder, all rich in protein. These ingredients should only be used when no natural pollen can be collected by the beekeeper. Collecting and using natural pollen as a supplement, when sufficient sources of pollen are not available to the bees achieve the best results.

Where to collect pollen

Fig. 9.7 A colony of Trigona. Pollen is found in the larger „sacks“

Fig. 9.8 Mud pots are useful as hives for Trigona

Fig. 9.9 Opening a plastic bag with pollen supplement

Natural pollen can be collected from the nests of Dammar bees (*Trigona spp.*) or, if honey hunting on Apis dorsata take place in the area, from the combs of Apis dorsata. Pollen should not be collected from *Apis cerana* colonies because of the risk of transferring viral and bacterial diseases such as TSBV and AFB.

The easiest way to secure a stable supply of natural pollen is to keep some Dammar bee colonies in the area. Dammar bees are very good pollen collectors (and pollinators). In an area with abundant pollen sources pollen production will be high. Honey production from Dammar bees is small, but can achieve a high price when sold for medicinal purposes. Below altitudes of approximately 1200 meters they will thrive well in a mud pot, stone wall or a simple hive made from a piece of split bamboo.

Feral Dammar bee colonies can be obtained from old stonewalls or Commiphora trees (*Commiphora spp.*). Colonies can easily be transferred to a simple hive and kept - without any maintenance - for supplying pollen.

Harvested pollen can be stored by mixing the pollen with powdered sugar and kept in an airtight container. The ratio should be approximately 3 parts of pollen to 2 parts of powdered sugar.

Pollen supplement based on collected pollen

Mix 100 gram natural pollen with some powdered sugar. Knead with Mulderry syrup until it becomes a soft paste. Store in heavy plastic bags. 50 - 100 grams in each bag. Seal airtight with cell tape.

To use the pollen substitute, put one bag in a beehive and cut it open with a knife. Do not remove all the plastic. The plastic will for some time keep the pollen supplement soft, making it easier for the bees to collect the pollen.

In frame hives the plastic bag is placed upside down op top of the frames.

In Mulderry hives the plastic bag can be fixed with a pin to the bottom of the hive.

Pollen substitute based on other protein sources

Fig. 9.10 A plastic bag will keep the pollen supplement soft

600 grams soybean flour.
200 grams dried bakers yeast.
200 grams skimmed milk powder.
35 grams dried fish meal.
2 grams of anise. (As an attractant).

All ingredients should be mixed dry and Mulderry Syrup added to a dough-like consistency. Formed into small balls or stored in a plastic bgag it can be placed on top the frames in hives.

Providing the bees with water

A source of water close to the hives is essential for successful beekeeping. The further away from the hive the water is found the more time and energy the bees have to use collecting water. The bees need water for keeping humidity stable in the hive so eggs can hatch. When it is hot outside bees also collect water and evaporate it to keep temperature stable in the hive. Water is also crucial for diluting honey or sugar candy before feeding the young larva or adults.

Watering the bees can be done with any small container filled with water and some wood chippings floating to prevent the bees from drowning. Chickens and dogs may empty the container frequently so make sure it is refilled. A better way of watering is using a plastic jar with a lid and a tiny hole near the bottom. Place the jar on a stone and adjust the lid until the water only drips slowly.

Nutrition of honeybees

The basic nutritional requirements for honey bees and humans are the same: carbohydrate, proteins, vitamins, fat, minerals and water.

Carbohydrate

Carbohydrate is the common name for all sugars; starch and cellulose are also carbohydrates but cannot be utilised by honeybees.

Carbohydrates provide the energy for motion, for keeping up temperature in the body and play an important role for secreting beeswax.

Nectar and honeydew are the main sources of sugars for the bees. Three sugars are particularly important to bees; sucrose and it breakdown products glucose and fructose. Sucrose – ordinary white sugar - is the main sugar found in nectar. During the conversion of nectar to honey the bees adds the enzyme invertase (sucrase) to break down the sucrose into glucose and fructose.

Other sugars that to various extent can be utilised by bees are; maltose, melizitose, raffinose and galactose.

Proteins

Proteins are very complex nitrogenous organic compounds built up of smaller units called amino acids. Amino acids are the „building blocks“ of the body. Apart from building cells and repairing tissue, they form antibodies to fight invading bacteria & viruses; they are part of the enzyme & hormonal system; they build nucleoproteins (RNA & DNA); they carry oxygen throughout the body and take part in muscle activity.

Proteins are broken down into their constituent amino acids during digestion, which are then absorbed and used to make new proteins in the body.

When bees digest pollen, the protein is broken down to amino acids. All living beings make use of approximately 20 amino acids in their life processes. Most of the amino acids can be synthesized in the body

When protein is broken down by digestion the result is 22 known amino acids. Eight are essential (cannot be manufactured by the body) the rest are non-essential (can be manufactured by the body with proper nutrition).

Vitamins

Most of the vitamins come from pollen or are synthesized by the bee. Only small amounts of vitamins are found in honey. The following vitamins are usually present in honeybees: Ascorbic acid (vitamin C), thiamine (vitamin B1), riboflavin (B2), pyridoxine (vitamin B6), nicotinic acid (vitamin B3), panthothenic acid (vitamin B5), biotin (vitamin H), inositol (the vitamin B complex) and folic acid (vitamin B9).

Since little is known about vitamin requirements of bees, other vitamins may be important.

Fat

The fats required is supplied from pollen, which usually contains about 5 % fat. Together with protein and glycogen, fat is stored in fat bodies, which are soft tissue packed in between organs of the bee. Fat bodies function as storage and a buffer, making fat, protein and glycogen available when needed.

Minerals

Pollen is the source of most of the minerals necessary for the bees. Sometimes bees can be seen collecting odd substances like sweat from skin of humans or cows urine. This could also be a source of minerals. The following minerals are considered important for bees: Boron, calcium, cobalt, copper, iodine, chlorine, iron, phosphorus, sodium, nickel, magnesium, manganese and zinc.

Water

Water is essential to catalyse the necessary chemical processes in the body to sustain life for all living beings. Honeybees also use water to dilute honey as larval and adult food and to liquefy crystallised honey. Under tropical conditions water play an important role to stabilise the microclimate in the hive. Bees collect and evaporate water to adapt temperature and humidity to optimum levels.

Chapter 10: How to do queen rearing

The first step to solve some of these problems mentioned is to set up a queen-rearing programme to produce the number of colonies needed for the project. Let's first define the terms Queen rearing and selective queen breeding:

Queen rearing is the process of producing new queens.

Selective queen breeding is the process of producing new queens with a number of predetermined and well-defined characteristics.

For *Apis cerana indica* selection for queen rearing/breeding should be done among colonies with the following characteristics:

Colonies with a low tendency to abscond or migrate

Colonies with a low tendency to swarm

Colonies with a proven disease tolerance, particularly tolerance against Thai Sac Brood Virus

Docile colonies with a honey production above the average

Few efforts has been made to set up selective breeding programmes seriously working to increase honey yields, reduce absconding and swarming, improve disease resistance and thereby reduce costs and increase returns of the large resources spent in the apiculture sector in till example India. The strains/ecotypes of A.cerana found in India represent a vast pool of diverse genetic resources, which – used in a selective breeding programme with A.cerana - would make rapid progress possible.

Although successful queen rearing with *Apis cerana indica* requires a different approach than the easy queen rearing with Apis mellifera it can be done by following the instructions below.

A simple method to produce queens

Fig. 10.1 A newly emerged queen

To be used by beekeepers I have designed a simple, reliable and easy method of queen rearing. The aim has been to design the tools and method as simple as possible, requiring no input - except training - from outside. More elaborate methods may claim a slightly higher success rate, and be appropriate at other levels of beekeeping, but I have seen little success of more sophisticated queen rearing methods in village beekeeping.

The method is based on studies of bee behaviour and the structure of queen cells in A.cerana colonies in Bangladesh and South India. Probably the dimensions of the queen cells mentioned below can be used with all tropical and sub-tropical *Apis cerana* subspecies/ strains with an average worker cell diameter of 4.25 mm.

The method differs from other methods in following ways:

The grafted cell cup is placed directly on the comb, not on frames. Before the queen emerges the queen cell can easily be transferred to another colony.

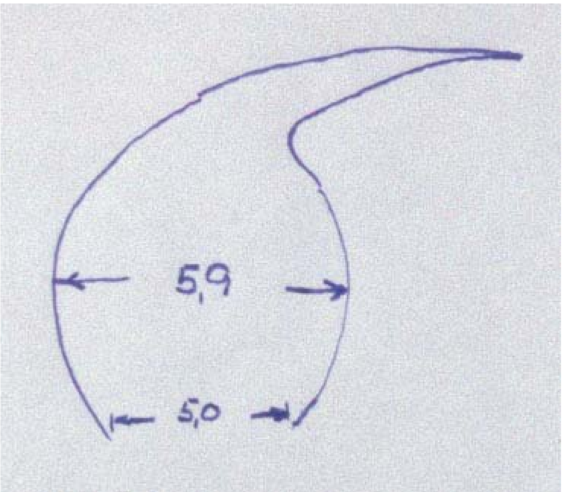


Fig. 10.2 The measurements valid for Apis cerana indica

The diameter of the cell cup is smaller (5.9 mm against conventionally claimed 8 mm - which is suitable for A.mellifera but not for A.cerana indica). The size of the cell cup is based on measurements of queen cells in about 200 A.cerana indica colonies.

The size of the entrance to the cell cup is reduced to 5.0 mm, which I found to increase the rate of success.

The grafted cells should be placed in a queen less colony between 3 to 6 hours after removing the old queen. Laying workers are likely to occur much faster in *A.cerana* colonies than in *A.mellifera* colonies, so timings suitable for *A.mellifera* should be avoided with *A.cerana*

Tools for making the cell cups

The most important tool to make the cell cups can easily be made from small sticks of bamboo or wood. With a knife and sandpaper one end of the stick is made circular and the tip is rounded. Two sticks are needed: One stick with a diameter of 5.9 mm, the other with a diameter of 5.0 mm. The exact measurements are important, and should be checked with a Vernier calliper.

Apart from the two sticks only some melted *A.cerana* wax, a small knife and a glass of water is needed.

Fig. 10.3 Two bamboo sticks are required for making cell cups

How to make the cell cups

Fig. 10.4 Few tools are required to make cell cups

The 5.9 mm stick is dipped in pure melted *A.cerana* wax three to four times, in a 90 degrees angle to the surface of the wax and cooled in water.

The stick is then tilted to a 45 degrees angle to the wax surface and dipped until a tip forms.(Fig 10. 6)

Use three fingers to draw the tip longer and make it pointed.(Fig 10.9)

The cell cup is cut - with a knife - to a length of 6 - 7 mm from the bottom.

The cell cup is transferred to the 5.0 mm stick and the entrance of the cup is shaped to the size of the stick. (Fig 10.8)

Fig. 10.5 A close look at natural cell cups and queen cells can give important knowledge of design

Fig. 10.6 Dipping the stick in melted beeswax

Fig. 10.7 A close up of a nearly completed cell cup

Fig. 10.8 Shaping the entrance of the cell cup

Fig. 10.9 Shaping the tip of the cell cup

How to do grafting

Fig. 10.10 Selecting the right larva

Fig. 10.11 To choose the correct age of larva is important

If royal jelly is available prime artificial cell cups using a fine clean brush. If it is not there, don't bother it is not a precondition for success. With a grafting needle a one-day-old larvae (Fig 10.11) is transferred from a worker cell to the cell cup. Slide the grafting needle down along the cell wall and under the tiny larva from the back (rounded) side. If you do not get the larva in the first try, leave it and try a new one. Take great care when

„sliding“ of the larva in the artificial cell cup. (Fig 10.12)

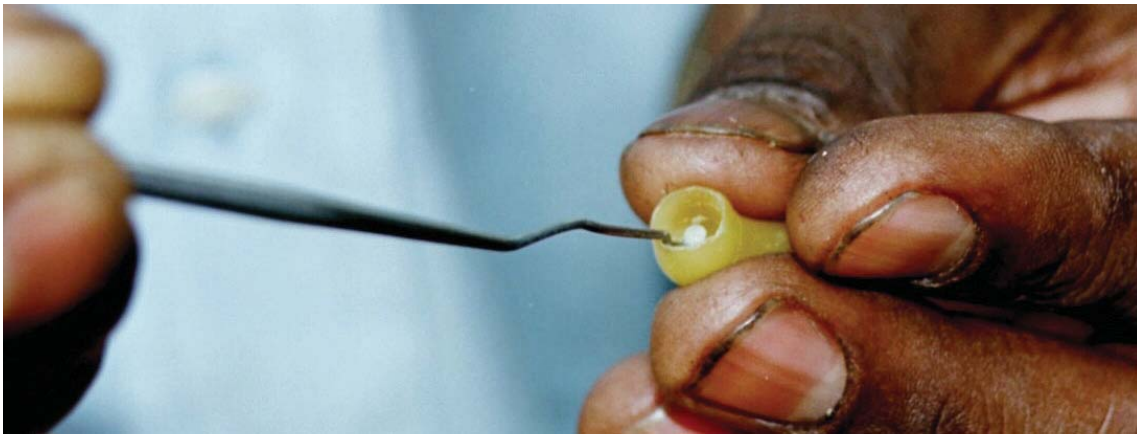


Fig. 10.12 Transferring the larva to a cell cup

Fig. 10.13 The larva is easily accessible if the cells are opened with a knife

Do not at any step in the process expose combs or cell cups to sunshine.

Shade, humid and clean condit-ions are a must. Cover artificial cell cups with a wet and clean piece of cloth as soon as graf-ting is completed.

Work slowly and with great care. Do not squeeze or kill any bees.

If you find it difficult to scoop up the young larva cells can be opened up with a knife.(Fig 10.13) Be careful not to damage the larva.

Fig. 10.14 Placing the cell cups in an area with open brood

After grafting the cell cup is placed in a cell on the comb (Fig 10.14) (in an area with young larvae) in a strong (minimum 14 combs) colony, where the old queen has been removed 3 to 6 hours before. Place a comb with unsealed honey and pollen next to the newly grafted cell cups. As a thumb rule 1 grafted cells can be placed (in the open brood area) per comb found in the colony.

A precondition for success is that the hive is „spilling over“ with young bees.

Fig. 10.15 The comb is ready to place in the cell builder colony

After grafting

Leave the hive well shaded and undisturbed for two days before inspecting to see how many of the graftings are successful. Lift the comb with the grafted cell cups carefully. Do not turn it up side down. Along with drawing the grafted cells the bees may start to build a few queen cells directly on the comb. These cells should be removed.

Fig. 10.16 A grafted cell accepted by the bees

From the second day after capping until two days before emerging, a queen cell is very sensitive to disturbance. Turning it up side down or shaking can dislocate and damage the pupae.

After 9 days (from grafting) queen cells can be transferred for making new colonies or requeening. If the age of the grafted larvae has been correct, the new queens will emerge between the 10^{th} and 12^{th} day from grafting. The development period of the queen is correlated to the temperature in the immediate surroundings of the queen cell. Even a minor rise in temperature will reduce the time it takes for the queen to develop.

More than 50% of the graftings will usually result in emerging queens.

Fig. 10.17 Queen cells which have been transferred to another colony for the queens to emerge

Fig. 10.18 If bees start drwing queen cells directly on the comb the cells should be removed

Grafting tools

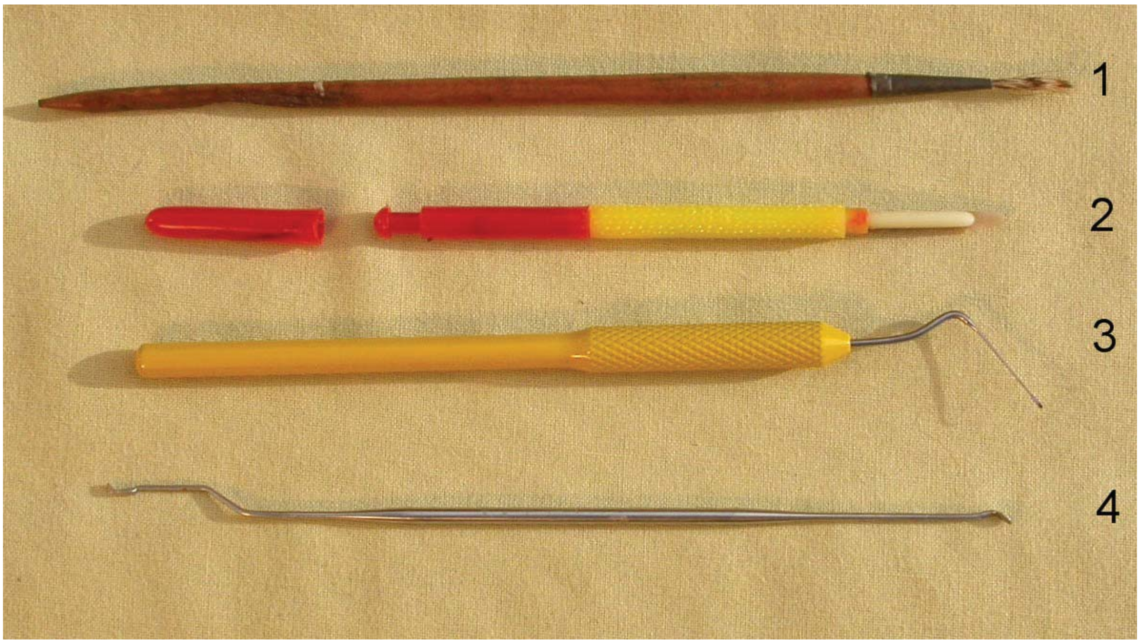


Fig. 10.19 Grafting tools

There are a number of grafting tools (transferring tools) designed to make the process of transfer as smooth as possible. A few are shown here.

No. 1. A fine and very flexible brush (where most of the hairs has been removed) is cheap and easily available. Moisten the hairs a little with water or royal jelly and slide the hairs along the wall of the cell and under the larva to transfer it. There is a low risk of damaging the larva when using a brush.

No. 2. A Chinese grafting tool. Use the button when placing the larva.

No. 3. A Swiss model. Very convenient to use but expensive. Because of the angle the hand is not blocking the view of the cell.

No.4. A standard design. If not available it can be made from a dentist's tool.

Transferring larva to cell cups depend most on practice. Simple tools can be used, like a matchstick, or a stem of fine grass. Below is shown an example of a Vietnamese queen rearers grafting tool. Made from a birds feather.

What make the bees rear queens

A number of more or less known factors influence the impulse for bees to rear new queens in a colony.

The following factors facillitates rearing of queens:

No queen present in the colony

Crowded colonies in rapid growth

Optimum age structure, i.e. a sufficient number of young nurse bees

Presence of drone brood or drones

Presence of a light nectar flow or booster feeding

Availability of pollen or feeding with pollen substitute

Favourable weather conditions

All initial attempts to rear queens should take place during the swarming season.

Preparing colonies for queen rearing

The bottleneck in queen rearing with *Apis cerana indica* is usually not to produce the desired number of queens, but to produce the necessary brood combs and young bees to

utilise the new queens. For each cell builder colony 4 to 5 strong "support" colonies are needed to make sufficient brood combs and bees. It always pays to prepare the needed number of colonies according to the plan in table 9.

Table 9: Plan for queen rearing

Day -21 (21 days before planned grafting)	All colonies to be used for queen rearing should be fed approximately 21 days prior to grafting (day 0). Use 100 ml of Mulderry syrup per day. Feed inside the hive to prevent robbing.
Day - 15 (15 days before grafting)	A medium strong colony is selected a cell builder (cell finishing colony). This colony is reinforced with combs with emerging brood (no bees) from other colonies from day - 15 and onwards until the colony is "spilling" over with bees. One comb every second day. Feeding of all colonies continues.
Day - 12 (12 days before grafting)	Check all colonies for and remove queen cells.
Day - 2. (2 days before grafting)	All colonies are checked for queen cells. If any are present, leave one or two for priming artificial cell cups with royal jelly. Remove the rest.
Day - 1. (1 day before grafting)	In the late afternoon the queen in cell builder colony is transferred to a new hive with three combs containing brood, honey and pollen and is to be fed for two weeks. The colony with the queen is shifted to a new place at least 1-2 kilometres away from the apiary. Marking two combs with open brood in the cell builder will make it easier to place the graftings the next day
Day 0. (Grafting)	Follow the instructions in the paragraph: How to do grafting.
Day + 2 (2 days after grafting)	Open the hive slowly and lift the frame with graftings a little, so you can check if the graftings have been accepted. If bees are working on the artificial cell cups close the hive and leave it. If the bees are not working on the cells repeat procedures described for grafting (day 0) If drones are present in the box above the queen excluder, open the top cover a little in the late afternoon to let them out. Otherwise they may die and block the queen excluder.
Day + 5 to +10 (5 days after grafting)	Queen cells should now be used for production of new colonies. Make new colonies in a box with 3-5 honey/pollen/ brood combs + bees - queen gate. (See the section: How to make nucleus colonies) Never turn capped queen cells upside down. Do not forget to leave a grafted queen cell to provide the cell builder colony with a new queen. Check all combs in the colony for not planned queen cells. Remove if any.
Day + 10 + 11 + 12	This is the last chance for making nucleus colonies. Use excess queen cells for requeening. From day 10 and onwards queens may start to emerge. The first emerging queen will usually kill unemerged queens.

Troubleshooting in queen rearing

Even seasoned queen breeders sometimes fail in making the bees accept graftings. Then there is only one thing to do: Get back to the starting point and ask the basic questions listed below. Then try again.

Like most beekeeping operations success in queen rearing depend on practical skills.

Table 10. Checklist for troubleshooting

Checklist	Yes	No
Does the colony have a sufficient number of young nurse bees?		
Is the age of the larvae correct?		
Is the size of queen cups appropriate to the local bees?		
Is there a light nectar flow or feeding?		
Is pollen available?		
Is the weather favourable for collecting nectar and pollen?		
Is there any chance the larvae were damaged during transfer?		
Is the hive placed in shaded and undisturbed place?		
Is drone brood or drones present?		
Is it the swarming season?		
Were the cell cups prepared from pure cerana wax?		

How to make nucleus colonies

Place 2 to 3 brood combs and 2 combs with pollen and nectar/honey in an empty hive. All combs with bees but make sure no queen is there. Gently loosen a capped queen cell from the brood combs in the cell builder colony and place it on the brood combs in the nucleus hive. Do not turn the queen cell up down and take care not to squeeze the queen cell when pushing the combs together.

Leave the hive well-shaded and undisturbed place. Bees from other colonies may try to rob honey from the nucleus hives. To avoid robbing reduce the size of the entrance so only one or two bees can pass at the same time. If robbing has started, close the entrance with a piece of net for a couple of days. Put a little water on the net twice a day. Bees will drink from there if they need water. Nucleus hives will usually loose the foraging bees, so check food is available until foraging start again. If there is a need to feed the bees, candy is the best choice. Candy is less likely to cause robbing than syrup.

Requeening

Unfortunately requeening is not a common management practice in A.cerana indica beekeeping despite it being a very easy way to improve performance of colonies. A young prolific queen has the ability to increase the size of a colony, and, thereby increase honey production and optimise the colony’s response to diseases and predators.

Requeening by using a grafted queen cell

As long as the new queen is introduced before emerging from the queen cell, requeening a colony usually is a simple procedure. The old queen is found and killed. All combs are then searched for queens a second time. It is not unusual to find two or more queens in a A.cerana colony.

Fig. 10.21 A Vietnamese model of a queen cage. If one end is left open and filled with candy it can be used for introduction of a queen

After 3 to 6 hours the cell with a new queen is placed on a comb with open brood. Make sure the tip of the queen cell is free so the queen can emerge, and take care not squeeze the cell while replacing combs. If a queen gate is used do not forget to remove it so the queen can pass unobstructed to her mating flight. Provided favourable weather and a sufficient number of drones for mating in the area, the queen usually start laying eggs after 8 to 15 days after introduction.

The hive should be left without disturbance for a week. For unknown reasons the worker bees have a tendency to kill the young queen, if disturbed, before she is firmly established in the colony.

Requeening by using a false queen cell

A piece of comb foundation (4x 6 cm) is shaped around a 7mm stick so it forms a tube.

One end of the tube is rounded over the end of the stick, leaving only a thin layer of wax at this end. With a needle, small holes are made at this end of the tube. The queen is placed in the false queen cell. The top end is closed and carefully drawn into a tip, used for placing the false queen cell on a comb with open brood. The worker bees will open the cell and release the queen.

Removal of queen(s) and other conditions: see above.

Requeening by using a transport cage

Transport cages can be made from wood and wire/wire mesh, but a cage made from plastic (Fig 10.22) is more convenient to work with. Provided sufficient nurse bees and watering, queens can be kept for 2 – 3 days in a transport cage. There are two compartments in the cage. The small compartment is filed with candy. The queen and 7- 10 young (hairy) nurse bees are placed in the larger compartment. Supply the bees with a few drops of water 2 –3 times a day and keep the cage in a cool and shaded place.

In the new colony the cage is placed between to combs with open brood. Remove the small plastic tab covering the candy. In a day or two the bees will eat the candy and release the queen. Removal of queen(s) and other conditions: see above.

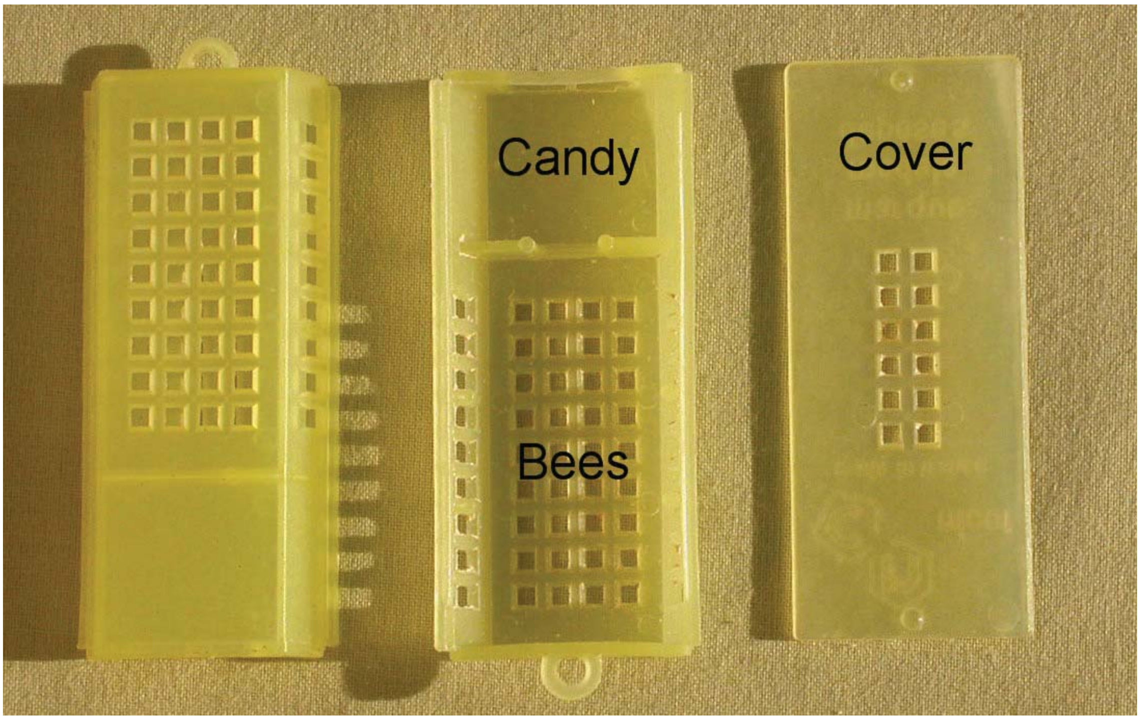


Fig. 10.22 A plastic cage for transport and introduction of queens

A warning

Unfortunately it is common practice for many beekeepers to use swarm cells from colonies of unknown origin when a new queen is needed. This should be avoided, because most swarm cells are found in colonies very prone to swarming. Using such swarm cells is likely to be a selection for colonies with a high tendency to swarm.

Development stages Apis cerana indica

Table 11. Development stages

Apis cerana indica
Tropics and subtropics (India)
Duration in days

	Egg stage	Larval stage in open cells	Pupae stage in sealed cells	Cell shape and size
Queen	**3**	**4-5**	**6-7**	**Circular 5,9 mm (centre) 5,0 mm (Entrance)**
Drone	**3**	**5-6**	**14-15**	**Hexagonal 5,24 mm**
Worker	**3**	**5,1**	**11**	**Hexagonal 4,25 mm**